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ABSTRACT

This is one of several teacher's guides for the 4M Company, a set of materials for teaching metric concepts and computation. This level of the program extends comparisons from two objects to comparisons involving three or more objects. Vocabulary includes superlatives (longest) as well as comparatives (longer). Students are introduced to six metric units: meter, decimeter, liter, deciliter, gram, and kilogram. They compare these units to properties of common objects and learn to measure with several tools. Conservation of length, liquid, and mass are also included. (Author/RH)

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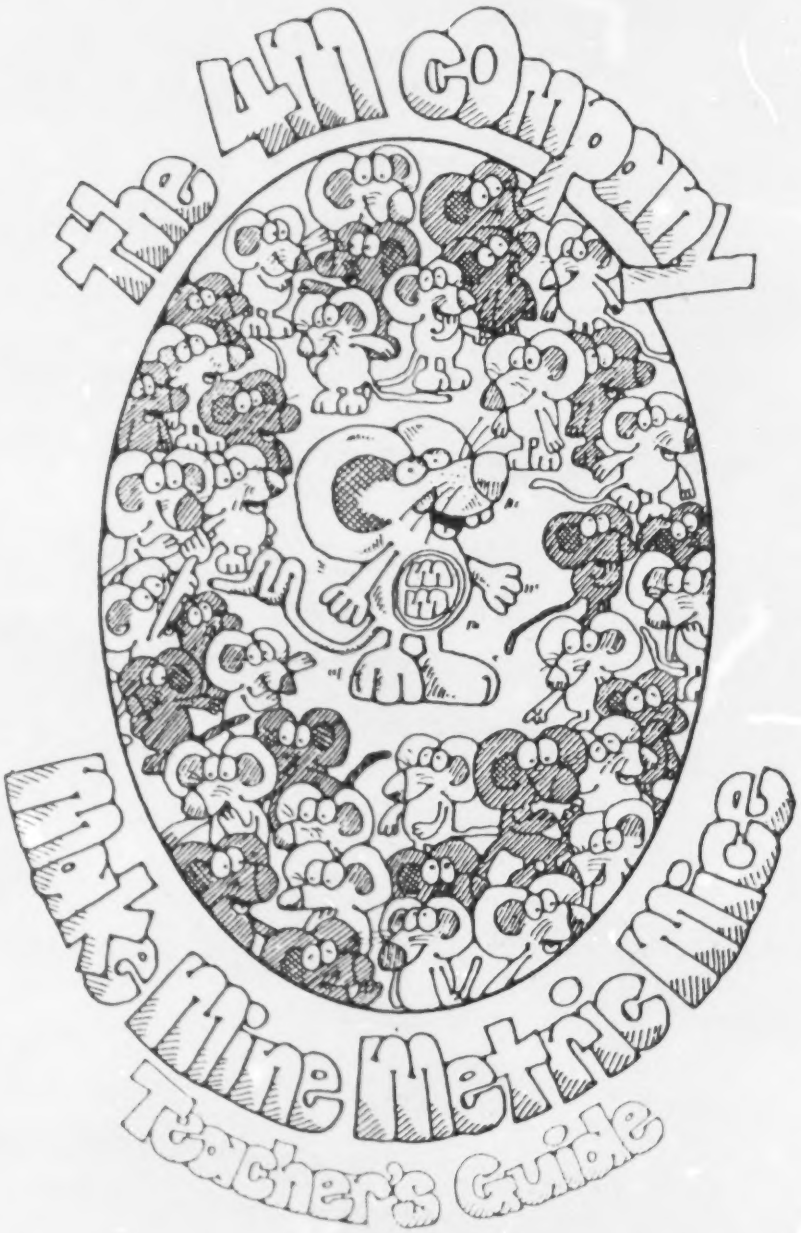




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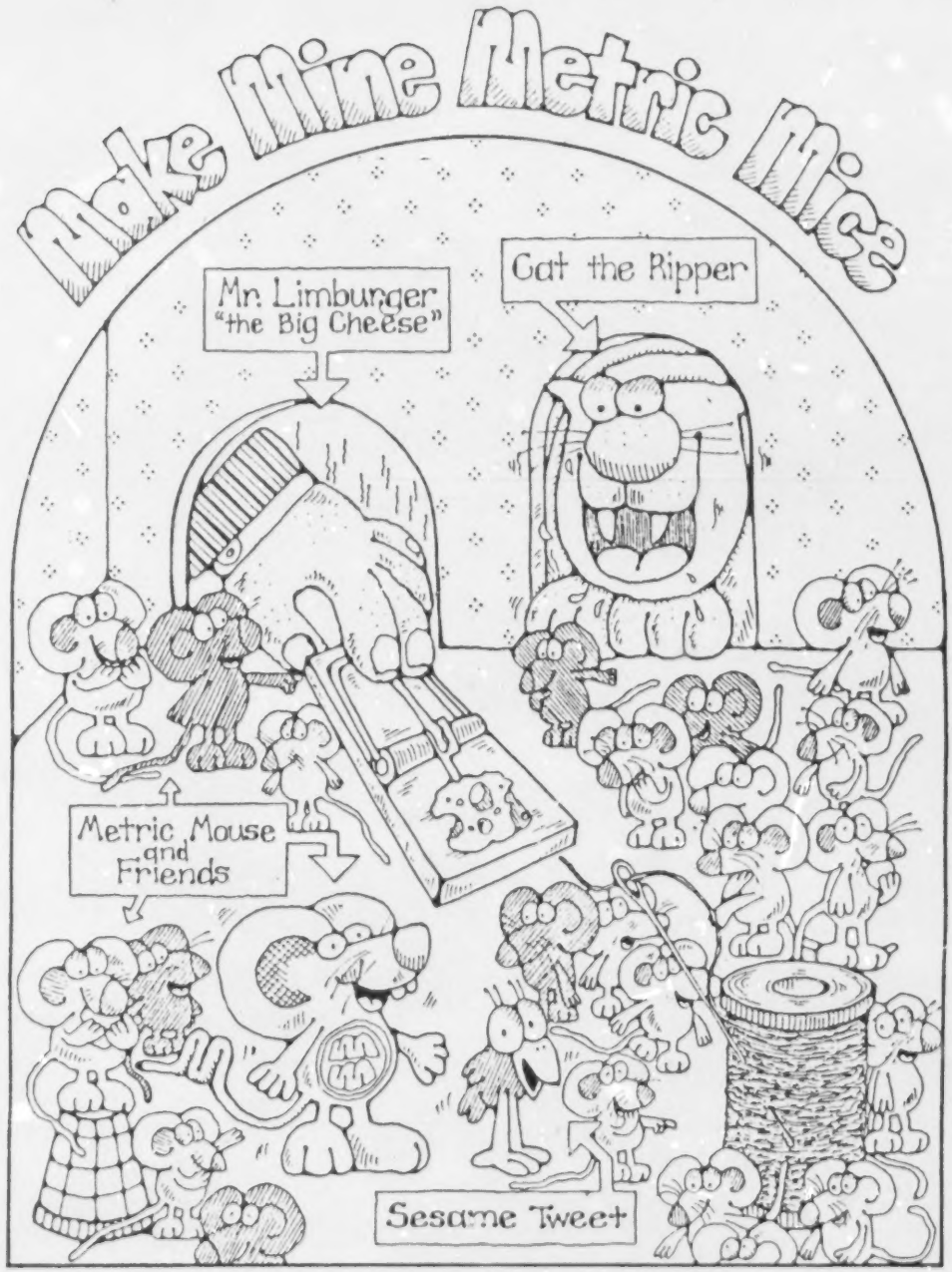
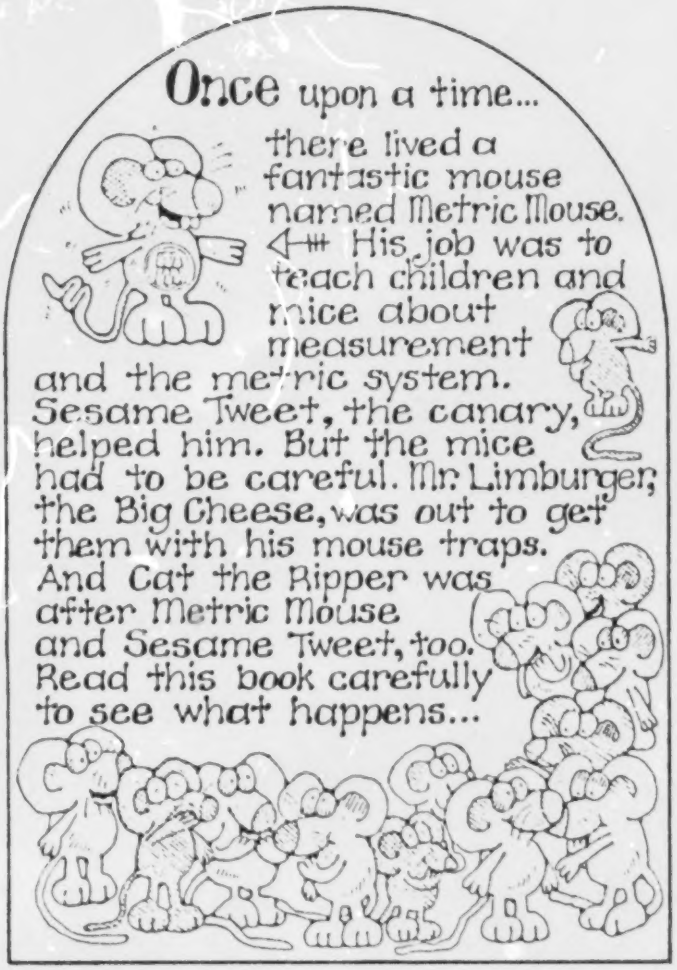
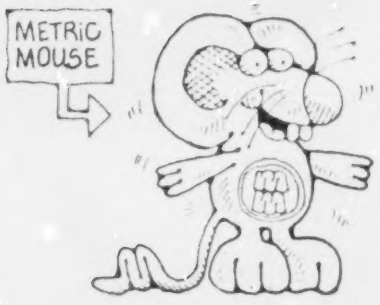

Make mine Metric Mice
Mr. Limburger "the Big Cheese"
Cat the Ripper
Metric Mouse and Friends
Sesame Tweet


Once upon a time...
there lived a fantastic mouse named Metric Mouse. His job was to teach children and mice about measurement and the metric system. Sesame Tweet, the canary, helped him. But the mice had to be careful. Mr. Limburger, the Big Cheese, was out to get them with his mouse traps. And Cat the Ripper was after Metric Mouse and Sesame Tweet, too. Read this book carefully to see what happens...

the 4M company

# the 4M company

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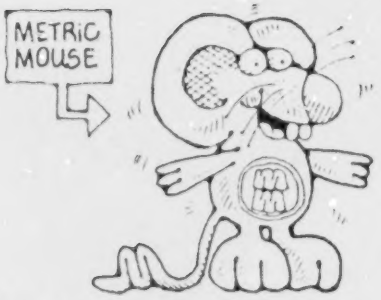
# the 4M company




to the teacher...
read carefully before
you begin teaching

Curriculum materials are only one of the factors involved in the learning process. No program can anticipate the other factors - your unique characteristics as a teacher, the characteristics of your students, and your classroom situation. Yet these factors must all be considered for a successful learning experience. It is you, the teacher, who must analyze these factors to make decisions and adjustments in the learning activities as described in this Teacher's Guide.

The 4M COMPANY provides a variety of classroom organizations: at times students will work as an entire class, at times they will work in small groups, and at times they will work alone. Depending on the unique combination of factors which make up your classroom, the procedures recommended in this Teacher's Guide may or may not work in your particular classroom. Feel free to adapt the program to meet your particular needs. Following the Teacher's Guide word-for-word is not important; learning the objectives of the program is!

You are a unique person, and no one will teach The 4M COMPANY exactly as you do. Your strengths, your weaknesses, your abilities, and your overall philosophy will influence your teaching. Keep in mind, however, the following roles which you must play as a teacher.

The role of a planner. The 4M COMPANY is an activity program, and you will be required to prepare materials for most lessons. Things will not always work out as you had planned, so be prepared to alter your plans if the need arises.

The role of a demonstrator. Although this Teacher's Guide outlines one approach to teaching the objectives of a lesson, you must decide if a given demonstration is working with your students. They are unique, and you may have to alter the demonstration to meet their level of understanding.

The role of a questioner. Instead of always giving answers, ask the children remedial questions that will clarify their thinking. Ask more difficult questions of children who need more challenge.

The role of a motivator. No student can be made to learn if he doesn't want to. The 4M COMPANY has tried to motivate children in several ways - the cartoon format of the booklets, the use of a story line for each grade level, and the use of games and activities. But in addition to our efforts, you will still need to motivate and encourage children to learn.

The role of a summarizer. At the conclusion of an activity, you encourage students to share their findings. It is important to summarize the results of each activity.

We have tried to make The 4M COMPANY an enjoyable and effective metric program. To a large extent your attitude will determine the success of the program. If you are unfamiliar with parts of the metric system, admit this to yourself and to your students. If you adopt a positive attitude of learning with your students, this will do much to create a good classroom environment. For ready reference, the Appendix to this Teacher's Guide contains a brief review of the metric system.

The following paragraphs deal specifically with this level of The 4M COMPANY. Please read them carefully.

## content

This level of the program extends comparisons from two objects to comparisons involving three or more objects. Vocabulary includes superlatives (longest) as well as comparatives (longer). Students are introduced to six metric units: meter, decimeter, liter, deciliter, gram, and kilogram. They compare these units to properties of common objects and learn to measure with the following tools: meter stick, decimeter strip, liter container, deciliter container, balance and 1-gram weights.

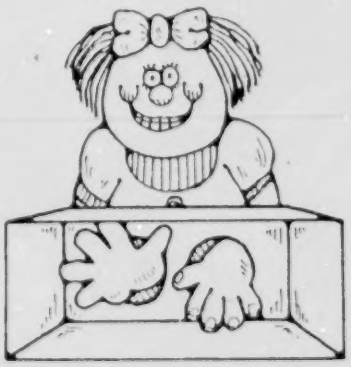
Conservation of length, liquid, and mass are also included. When a child conserves, he understands that the length (or amount of liquid, or mass) of an object does not change if it is repositioned in space. Mastery of conservation is not expected of all students at this age level.

## management

Management will be a key factor in the success of this program. In general, kindergarten and first grade children will need direct supervision on most activities. There are two workbook pages for each new concept. The first page should be done as a group with plenty of discussion. Children can then do the second page on their own. Be sure to discuss the pages after they are completed. Do not let children work ahead on their own since directions change from page to page.

## feel box

The Feel Box has been found to be very successful and is easily made from a cardboard box. Two holes are cut in the bottom of an open rectangular box. The box will be turned on its side and children asked to stick their hands through the holes to hold and compare objects by feel rather than by sight. Care should be taken not to make the holes so large that children can easily see into its open side. Sleeves or cuffs may be placed around the holes, as well, to prevent peeking.



## coloring

Many students enjoy coloring the pictures in their metric booklets. This can serve as an aid in classroom management. While you work with a small group, others can color in their books. However, no child should be forced to color, and care should be taken not to compare or judge the quality of the coloring.

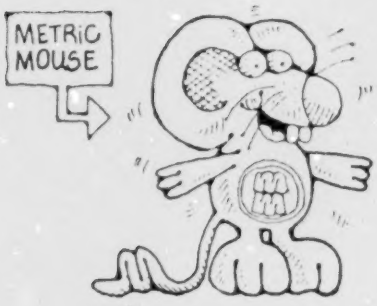
## spelling

At the time of printing there was no national policy on the spelling of the words "meter" and "liter". Some groups are advocating "metre" and "litre". We have gone with the "er" spellings. However, since students will probably see both spellings, it is a good idea to expose them to both. Both spellings are correct.

## suggestion

Here is another suggestion which you may find helpful. When several illustrations appear on one page, some kindergarten and first grade children have difficulty focusing their attention on a given exercise. To help students focus their attention, give each child a piece of construction paper (10 cm x 15 cm) so that they can use it to block out pictures not being discussed.

# the 4M company



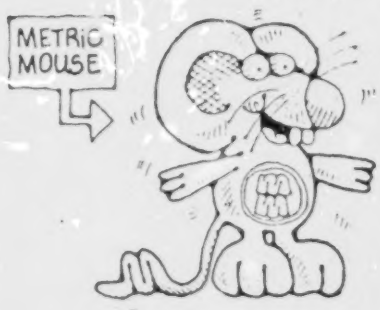

## Materials

| section number | materials description |
|---|---|
| 1 | various objects to compare, Feel Box, the story of Leilani and the Three Menehunes (see page 9), paper, crayons, 5 or 6 paper circles which vary in size (or wooden shapes if available), flashcards (see page 39) |
| 2 | meter stick, flashcards and decimeter strips cut from back of Teacher's Guide |
| 3 | objects to compare, pencils, Cuisenaire rods (or straws cut to different lengths), decimeter strips (from back of Teacher's Guide), Feel Box, paper strips (longer and shorter than a decimeter, longer and shorter than a meter), flashcards (cut from back of Teacher's Guide), masking tape |
| 4 | pencils of same length, 2 decimeter strips, string |
| 5 | pencils (2 the same length, others different lengths) or straws, string |
| 6 | 1 giant hand and 1 menehune hand per student (duplicated by teacher from patterns in the back of the Teacher's Guide), several meter sticks |
| 7 | meter stick marked in decimeters, adding machine tape, masking tape, decimeter strips (cut from the back of the Teacher's Guide) |
| 8 | balance; variety of things to compare including coins, gram and kilogram weights, styrofoam balls, steel balls, etc.; 3 empty milk cartons |
| 9 | balance; wooden blocks (or nickels or metal washers) to use as arbitrary weights; 1-gram weights; kilogram weight; a variety of things to weigh; for page 40 a pencil, an eraser, and a penny; for page 41 a shoe, five 1-gram weights, and a quart milk carton filled with sand and stapled shut; flashcards (pages 43-45) |
| 10 | balance, modeling clay or Play Doh |

| section number | materials description |
|---|---|
| 11 | a variety of containers of different shapes and sizes (include a liter and a deciliter), water (colored water is desirable), plastic dishpan (recommended to contain spills); flashcards (from back of Teacher's Guide) |
| 12 | 2 identical containers (baby food jars are good), one tall thin container (stuffed olive jar is good), other containers, water (colored water is desirable) |
| 13 | a variety of containers; a small cup; deciliter measure; liter measure; bucket (pitcher, jar, etc. to measure in liters); for page 46 an empty quart milk carton, an empty half-gallon milk carton, and an empty gallon jug (bleach bottle); for page 47 an empty half-pint milk carton, an empty soda can, a liter measure; water, funnel and plastic dishpan recommended to catch spills |
| 14 | glass of warm water, glass of ice water, thermometers, demonstration thermometer (if available); flashcards (from back of Teacher's Guide) |

# the 4th company

## section I · larger·largest:smaller·smallest




Objectives: Given two (three) physical objects, identify the larger/smaller, bigger/littler (largest/smallest, biggest/littlest).

Given an illustration of two (three) objects, identify the larger/smaller, bigger/littler (largest/smallest, biggest/littlest).

Given the names of three common objects which differ greatly in size, identify the largest/smallest, biggest/littlest.

Given six similar shapes that vary in size, arrange them in order from smallest to largest (largest to smallest).

Materials: various objects to compare, Feel Box, the story of Leilani and the Three Menehunes (see page 9), paper, crayons, 5 or 6 paper circles which vary in size (or wooden shapes if available), flashcards (see page 39)

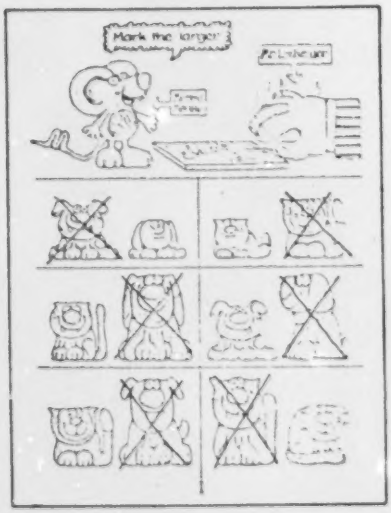
Vocabulary: larger, smaller, largest, smallest

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Hold up two objects which vary in size and point out that one object is "larger" than the other. Then hold up two more objects and ask the children to identify the "larger" object. Repeat several times.

2. Let one child select an object in the room. Then let another child try to find an object in the room which is larger. Discuss if necessary and repeat several times.

3. Draw two circles on the board, one large and one small. Write the word "larger", then place a mark on the larger and explain that you have marked the larger circle. Assign page 1 and do as a group.



4. Now hold up three objects which vary in size. Explain that one is the "largest" because it is larger than both of the other objects (NOTE: when comparing 2 objects we speak of "larger", when comparing 3 or more objects we speak of "largest"). Hold up 3 different objects and ask children to select the largest.

5. Use the Feel Box with 2 objects. Ask the student "which is the larger?" Then, using the same student and same objects, present a third object and ask, "Which is the largest?"

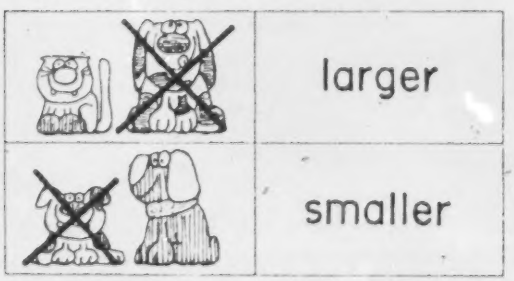
6. Let each of three students select an object in the room. Then as a group decide which is the largest.

7. See who can name the "largest" thing.

8. Draw 3 circles of different size on the board. Write the word "largest", stressing the "est". Then mark the largest. Assign pages 2 and 3.

9. Repeat the same general procedures for the concepts "smaller" and "smallest". Use pages 4, 5 and 6 in the workbook.

10. Turn to the back of the Teacher's Guide and cut out the 8 cards relating to the concepts "larger, largest, smaller, smallest". (You may laminate them or mount them on tag board if you wish). It is a good idea to review these words throughout the school year until all children can read the words. Stress the endings "er" and "est". As a class activity let various children match the pictures to the words.

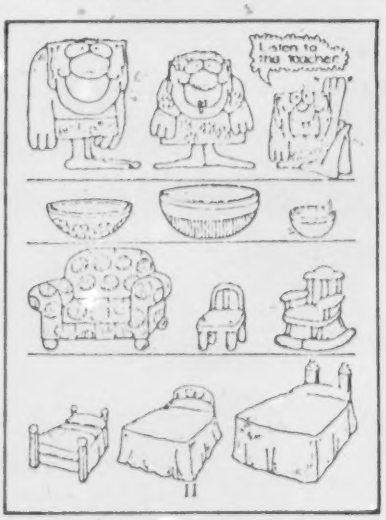



11. Point out that "large" and "big" mean the same thing. After adequate discussion, assign pages 7 and 8 on "bigger" and "biggest". Then do the same for "small" and "little". Use pages 9 and 10.

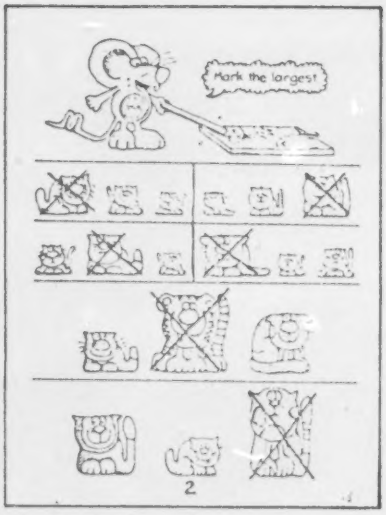
12. As an optional activity give the children crayons and paper and ask them to draw and label their own families. As a group activity, show each child's drawing and discuss it. Who is the largest? smallest? Etc.

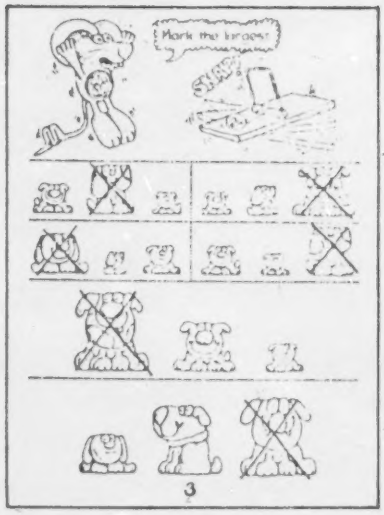
13. Have each child arrange 5 or 6 paper circles (or a set of wooden shapes) from smallest to largest (left to right), then from largest to smallest. The arrangements can be made in various positions: left to right, right to left, top to bottom, etc.

14. Read the children the story of "Leilani and the Three Menehunes" on on page 9. Using page 11 of the workbook, ask the class, "Who is the largest Menehune? Who is the next largest Menehune? Who is the smallest Menehune?" Let each student select a color for Papa Menehune and color his chair, bowl, and bed that color. Do the same for Mama and Baby, selecting a different color for each.




15. Call out names of three common objects which vary greatly in size. Have students identify the largest/smallest (biggest/littlest). Examples: elephant, mouse, dog; house, motorcycle, car; shoe, man, truck.


Mark the largest
2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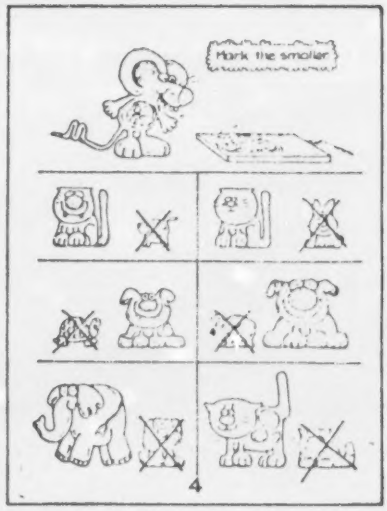
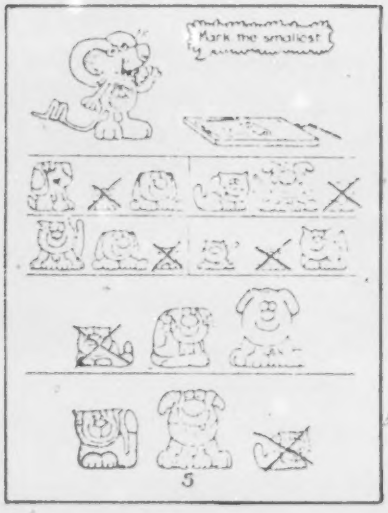
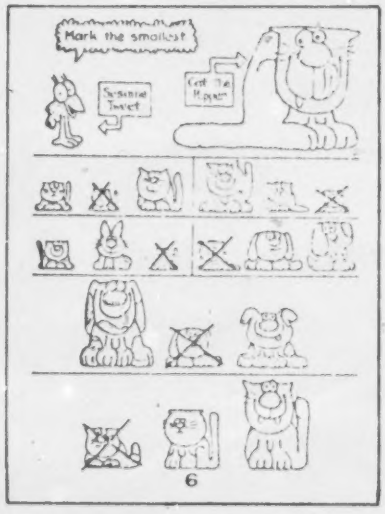
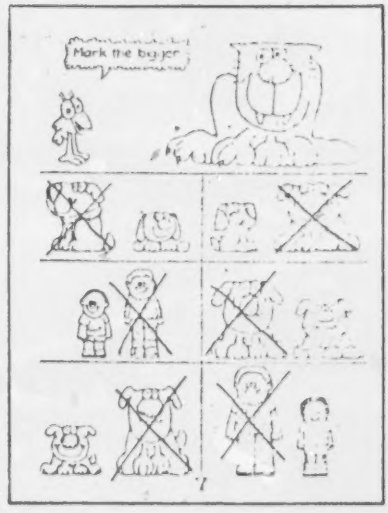
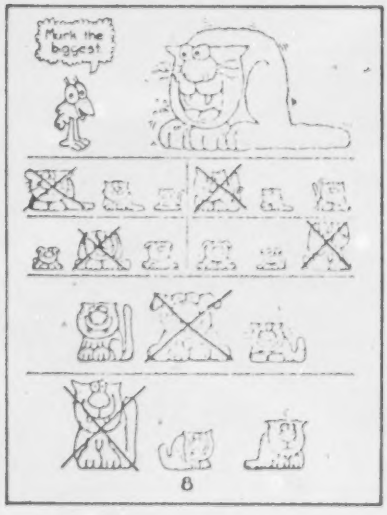
3


Mark the smaller
4


Mark the smallest
5


Mark the smallest
Get the Rabbit
6


Mark the bigger
7


Mark the biggest
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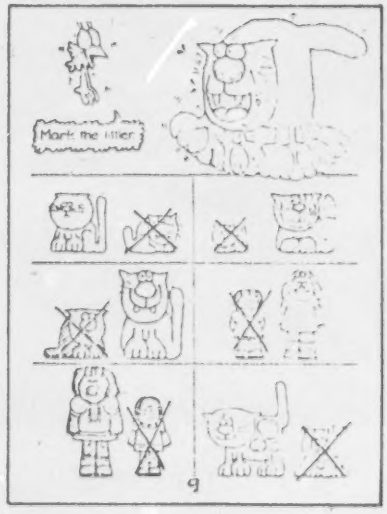
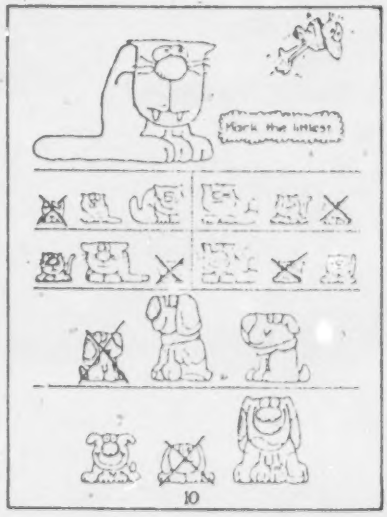

Mark the taller
9


Mark the littlest
10

## Leilani and the Three Menehunes

Once upon a time, on the island of Kauai, lived a little girl called Leilani. Leilani loved to romp and play. She loved to run into the forest to gather wild flowers or to chase lizards.

One day she wandered far from home, looking for flowers. She found herself in a strange and lonely forest, and there she came upon a little house in which three Menehunes lived. But Leilani did not know that three Menehunes lived in this house. One was Great Big Papa Menehune, one was Middle-Sized Mama Menehune, and one was Little Baby Menehune.

The door of the little house was open; so Leilani peeped in and saw that it was quite empty. She stepped inside to look about a bit; no one was home. The three Menehunes had just gone out for a walk to look for bananas and papayas. They had left their three bowls of poi on the table.

The poi smelled very good, and Leilani was suddenly very hungry. So she tasted the poi in the great big bowl, which belonged to Great Big Papa Menehune. But it was too thick.

Then she tasted the poi in the middle-sized bowl, which belonged to Middle-Sized Mama Menehune. But it was too thin and runny.

Then she tasted the poi in the little bowl, which belonged to the Little Baby Menehune. It was just right, and she ate it all up.

Leilani then looked about the room and saw three chairs. She sat down in the great big chair, which belonged to Great Big Papa Menehune. But it was too hard.

She then tried the middle-sized chair, which belonged to Middle-Sized Mama Menehune. But it was too soft.

So she tried the little chair, which belonged to Little Baby Menehune. It was just right. But when she sat in the little chair, she broke it.

By this time Leilani was very tired, and she went into another room where she saw three beds. She tried the great big bed, which belonged to Great Big Papa Menehune. But it was too hard.

Then she tried the middle-sized bed, which belonged to Middle-Sized Mama Menehune. But it was too soft.

She then tried the little bed, which belonged to Little Baby Menehune, and she found it just right; so she lay down upon it and fell fast asleep.

While Leilani was lying fast asleep, the three Menehunes came home from their walk, and they went quickly to the kitchen to get their poi.

Great Big Papa Menehune looked into his bowl and said in his great big voice, "Somebody has been tasting my poi!"

Then Middle-Sized Mama Menehune looked into her bowl and said in her middle-sized voice, "Somebody has been tasting my poi!"

And Little Baby Menehune looked into his bowl and cried in his little voice, "Somebody has been tasting my poi, and has eaten it all up!"

Then they looked at their chairs and Great Big Papa Menehune said, "Somebody has been sitting in my chair!"

And Middle-Sized Mama Menehune said, "Somebody has been sitting in my chair!"

And Little Baby Menehune cried, "Somebody has been sitting in my chair and has broken it all to pieces!"

The three Menehunes then went into their bedroom, and Great Big Papa Menehune said, "Somebody has been lying in my bed!"

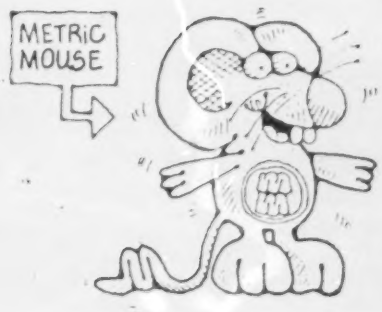
And Middle-Sized Mama Menehune said, "Somebody has been lying in my bed!"

And Little Baby Menehune cried, "Somebody has been lying in my bed, and here she is!"

At that, Leilani woke in fright and jumped out of the nearest window. She ran away as fast as her legs could carry her, and she never went again to the little house of the Three Menehunes.

# the 4th company

## section 2 · taller · tallest : shorter · shortest




Objectives: Given two (three) physical objects, identify the taller/shorter (tallest/shortest).

Given an illustration of two (three) common objects, identify the taller/shorter (tallest/shortest).

Given the names of three common objects which differ greatly in height, identify the tallest/shortest.

Given a decimeter strip and an illustration of an object, determine by direct comparison if the object is taller/shorter than one decimeter.

Materials: meter stick, flashcards and decimeter strips cut from back of Teacher's Guide

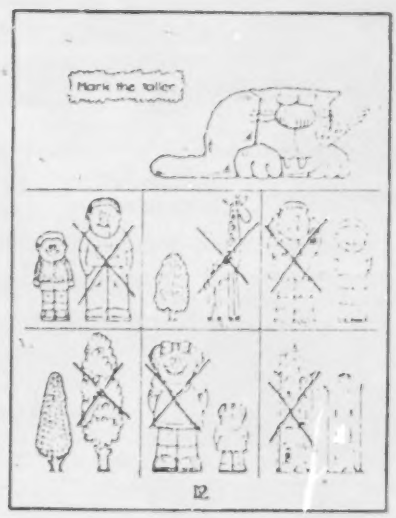
Vocabulary: taller, shorter, tallest, shortest, meter, decimeter

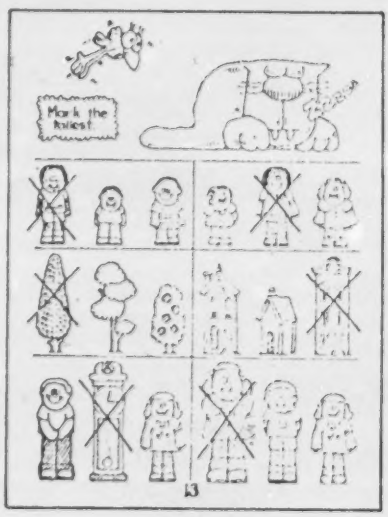
SUGGESTED PROCEDURE AND ACTIVITIES:

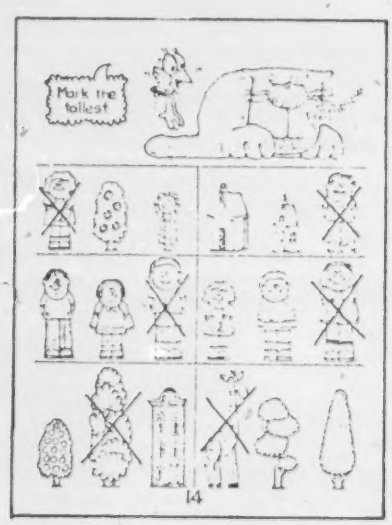
1. Demonstrate the concept of "taller" by comparing the heights of two children.

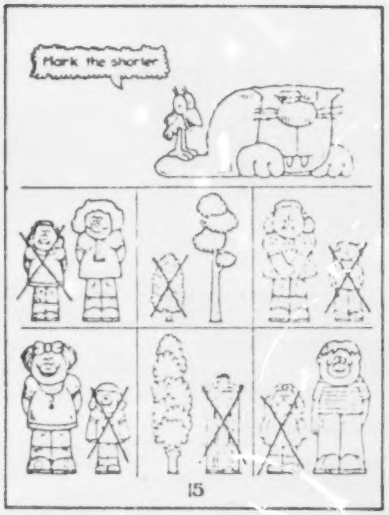
2. Draw a tall object and a short object on the board. Mark the taller one. Repeat, letting children mark the drawings. Then assign page 12.

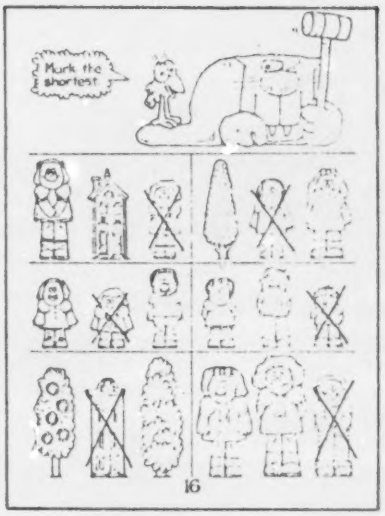
3. Demonstrate the concept of "tallest" by having three children come forward and letting the class determine who is the tallest. Recall the story of the "Three Menehunes" and ask, "Who was the tallest?" Explain that "taller" is used when comparing the heights of two things, and "tallest" is used when comparing three or more things.

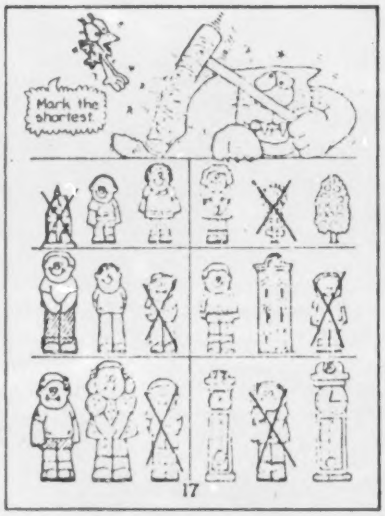





4. Draw three people on the board, mark the tallest. Repeat, letting students mark the tallest. Then assign pages 13 and 14.

5. Repeat activities 1-5 using the concepts "shorter, shortest". Use pages 15, 16 and 17.

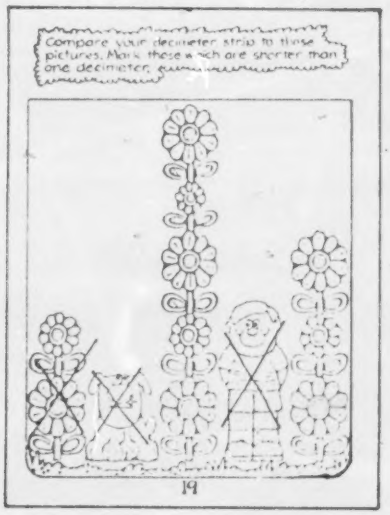
6. Introduce the meter stick. Explain that it is used all over the world to measure things. The meter is used to tell how long or how tall something is. Have each child stand beside a meter stick to see if he is taller or shorter than a meter.

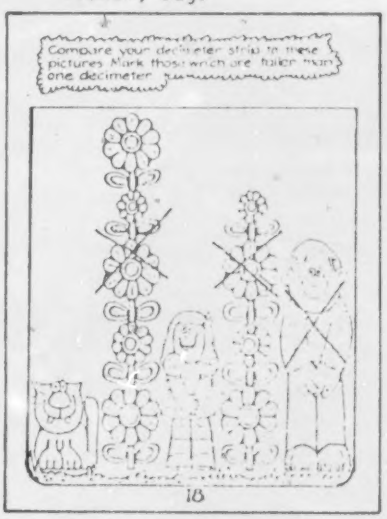
7. Cut out the 8 flashcards relating to the concepts "taller, tallest, shorter, shortest" from the back of the Teacher's Guide. As a class activity let various children match the pictures to the words.

8. Introduce the decimeter. Like the meter it is used to measure height (how tall something is) and length (how long something is). Compare the meter stick to a decimeter strip; ask which is taller/shorter. Draw a stick man on the chalkboard (or use a flannel board and various sized cut outs of people, animals, trees, etc.) and ask if the figure is taller or shorter than a decimeter. Demonstrate how to compare the decimeter strip to the figure by lining up the bottom edges and comparing the tops. Make some figures taller and some shorter than one decimeter and let various children come forward to compare the figures to a decimeter strip.

9. Cut out a decimeter strip for each child (from the back of the Teacher's Guide). Do pages 18 and 19 as a group. On one page mark pictures taller than a decimeter and on the next page mark those shorter than a decimeter. Collect the decimeter strips for later use.

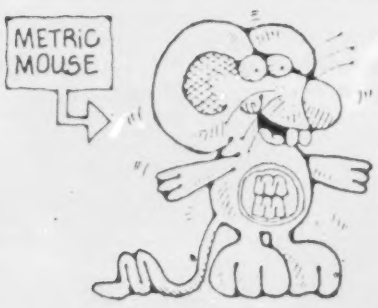
10. Call out the names of three common objects which vary in height. Have students identify the tallest/shortest. Examples: man, mouse, giraffe; tree, flower, bug.



# the 4th company

## section 3 · longer · longest : shorter · shortest




Objectives: Given two (three) physical objects, identify the longer/shorter (longest/shortest).

Given an illustration of two (three) common objects, identify the longer/shorter (longest/shortest).

Given a meter stick, find objects longer/shorter than one meter.

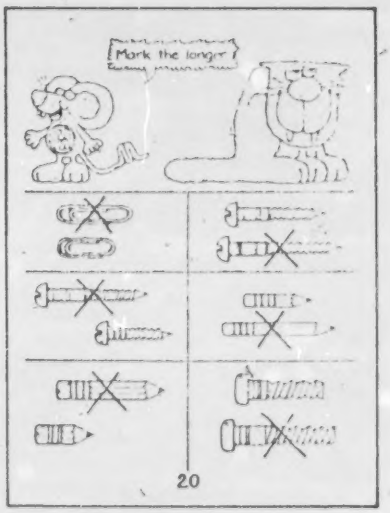
Given a decimeter strip and an illustration of an object, determine by direct comparison if the object is longer/shorter than one decimeter.

Materials: objects to compare, pencils, Cuisenaire rods (or straws cut to different lengths), decimeter strips (from back of Teacher's Guide), Feel Box, paper strips (longer and shorter than a decimeter, longer and shorter than a meter), flashcards, (cut from back of Teacher's Guide), masking tape

Vocabulary: longer, longest, shorter, shortest, meter, decimeter

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Introduce the concept of longer by holding up two pencils which vary in length. Place the pencils side by side so that the eraser ends are even. Then compare the other ends. "This pencil is longer because it sticks out more when the other ends are even." Demonstrate with other objects, letting the class tell which is longer.
2. Place many objects on the table. Hold one up, and ask someone to come forward and find an object on the table which is longer. Have the student compare their lengths for the class to see by holding the objects side by side with one set of ends even and comparing the other ends. Repeat so that many children can participate.
3. On the chalkboard draw two lines, one obviously longer than the other. Ask someone to come up and mark the longer one. Repeat a few times then assign page 20.



4. Draw one line on the chalkboard, ask someone to draw one longer than yours. Then draw a third one so that it is the longest. Explain that your line is the longest because it is longer than the first line and longer than the second line. Draw another, even longer line and ask, "Now which line is the longest?" Explain that when we compare just two things we use longer, and when we compare three or more things we use longest. Repeat the activity so that many students can participate.

5. Using various sized pencils, straws, Cuisenaire rods (if available), and a decimeter strip, hold up three objects at a time and ask which is the longest. Repeat as necessary.

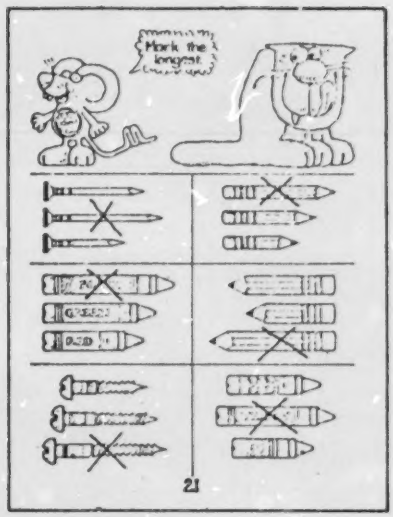
6. Do pages 21-22 in the workbook.

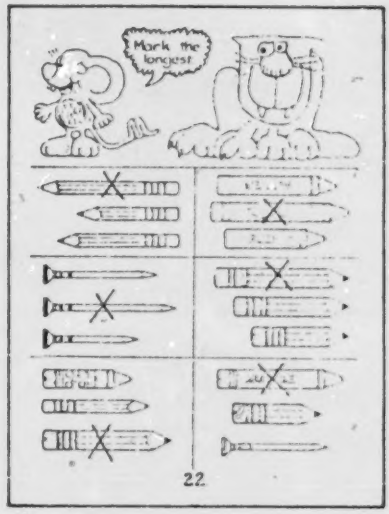
7. Use the Feel Box. Give a student two objects (Cuisenaire rods are ideal here) and ask him which is longer. Then hand him a third object and ask which is the longest.

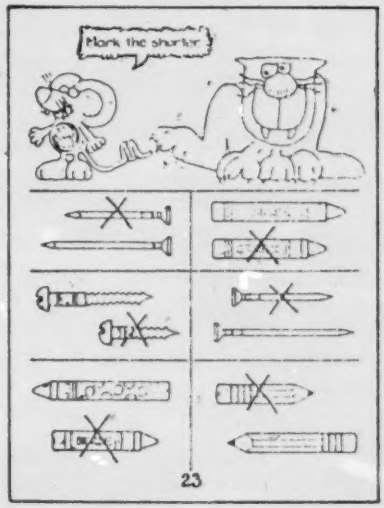
8. Repeat activities 1-8 using the concepts "shorter, shortest". Use pages 23, 24 and 25.

9. Introduce the meter stick again and as a group find things in the room longer and shorter than a meter.

10. Cut several strips of paper, some shorter and some longer than a decimeter. Make one longer than a meter and at least one between a meter and a decimeter. Use the meter stick, a decimeter strip, and the paper strips. Lay out in front of the group two, three, or four of these items at a time. Ask various questions to allow students practice in saying "meter", "decimeter", "shorter", "shortest", "longer", "longest". For instance, if the decimeter strip is the shortest, ask the group, "Which is the shortest?" Do several of this type of question. Then try another form of question by setting out the meter stick and one paper strip and asking, "What is the meter, the longer or the shorter?" Add a third strip and ask, "What is the meter,



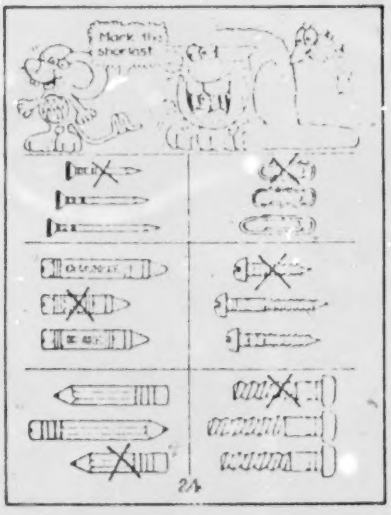



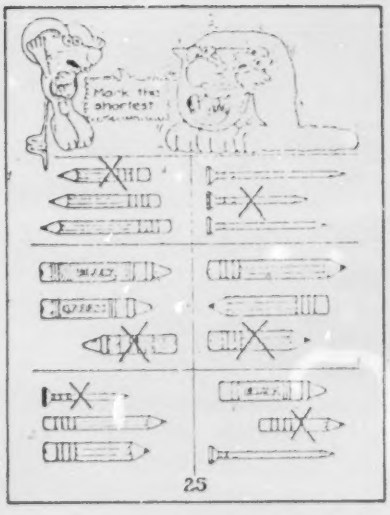
the longest or the shortest?" Repeat with 2, then 3 objects dropping out the verbal cue to use "-er" or "-est". Repeat this type of group practice often throughout the year to reinforce vocabulary.

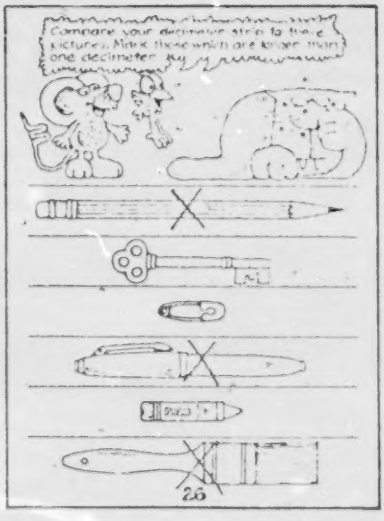
11. Turn to the back of the Teacher's Guide and cut out the eight flashcards relating to the concepts "longer, longest, shorter, shortest". As a class activity, let various children match the pictures to the words.

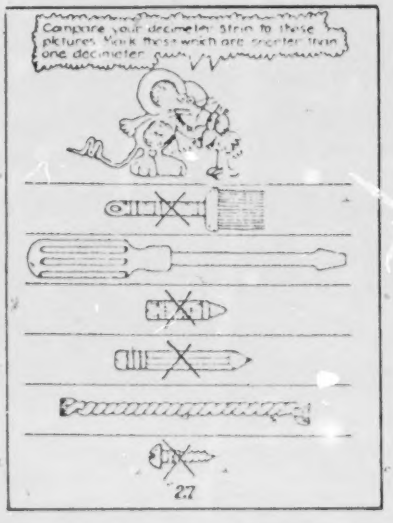
12. Cut 2 strips of masking tape very nearly the same length. Tape one strip on one end of the chalkboard. Tape the other strip on the other end of the chalkboard. Ask which is longer. Tell them that they cannot move the strips next to each other. Ask the students how they might be able to find a way to tell for sure which strip is longer. Some solutions might be: a. cut a piece of string the same length as one strip of tape and compare the length of the string with the length of the other strip; b. match the length of a certain object with one strip of tape, match the length of another object with the other strip of tape, then match the two objects and compare the lengths.

13. Take a strip of tape a little longer than a decimeter on the chalkboard. Ask the class if the tape is longer or shorter than one decimeter. Let them guess then ask how they might make sure. Let someone use a decimeter strip to check. Point out the need to first line up one set of ends evenly and then check the other ends to see which has more length. Do more examples with chalk lines if necessary. Give each child a decimeter strip and do pages 26 and 27 as a group.



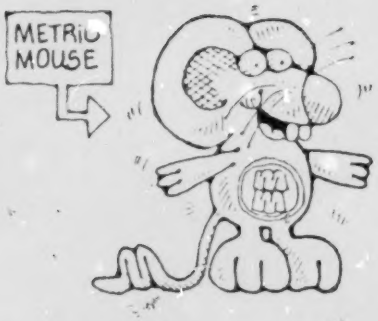



# the 4th company

## section 4 · conservation of length



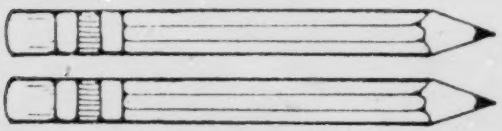

Objectives: Given two objects with equal lengths, state that both are still the same length when one of them is moved. (Mastery not expected of all children at this age level.)

Materials: pencils of same length, 2 decimeter strips, string

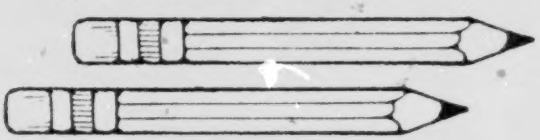
Vocabulary: longer, shorter, same length

SUGGESTED PROCEDURE AND ACTIVITIES:

1. It is preferable to work in small groups. Take two pencils (or other objects) of equal length. Place them on a table as follows:



Ask, "Which is longer, or are they the same length?" After it is established that they are the same length (you may have to hold them side by side), move one pencil so that they look like this:



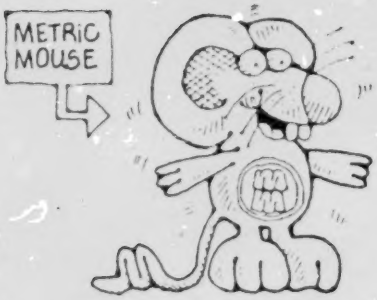
Ask, "Which is longer, or are they the same length?" If children cannot conserve length, their perceptions will fool them and they will say that one of the pencils is longer. If so, explain that moving a pencil does not change its length.

2. Repeat with two decimeter strips. Point out that a decimeter is a decimeter, no matter how it is moved. Other items can also be used: straws, dowels, etc. Try using a pair of slippers or shoes. Ask different children to respond.

3. Take two strings of equal length. Place them side by side and ask, "Which is longer? Or are they the same length?" After it is determined that they are equal, bend one and repeat the questions. Ask, "If bugs crawl along each string from one end to the other end, do they go the same distance, or does one bug have a longer crawl?"

# the 4M company

## section 5 · length: indirect comparison




Objectives: Given two lengths that cannot be compared directly, determine the longer/shorter by using a reference object.

Materials: pencils (2 the same length, others different lengths) or straws, string

Vocabulary: same length

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Hold up two pencils which are the same length and ask, "Which pencil is longer?" Then place them side by side to compare their lengths. Point out that both ends are even. "This means the pencils have the same length."

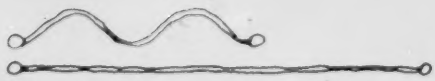
2. Take two pencils the same length and hold them in your hands so that the eraser ends are covered (in your hands) and the other ends are at different heights. Ask, "Do these pencils have the same length?" After they guess, discuss how to verify their guesses by pointing out that we have to look at both ends. Place the pencils so that the eraser ends are even. "See, these pencils have the same length because both ends are even." Repeat with pencils of different lengths, making shorter ones appear longer by hiding one set of ends in you hand.

3. Now hold two pencils in your hands so that the visible ends are even. Ask, "Are these pencils the same length?" As before, both ends must be compared. Repeat with a variety of lengths, some the same and some different.

4. Cut two different lengths of string. Arrange them on a table (or on overhead projector) so that the ends begin and end evenly, but the longer string is curved and the shorter is straight.

Ask, "Do these pieces of string have the same length?" Before children answer make the longer one straight

and explain that they do not have the same length. Wiggle the longer one again and point out that both ends are even, but since one was wiggly and the other one straight it was difficult to compare. Repeat a few more times, letting students straighten and compare the strings.



Then ask, "But is a wiggly string always the longer one?" Place two strings, the longer one straight and the shorter one wiggly.

Ask, "Which is longer?" After the class guesses, let a child come up and straighten the wiggly string to compare. Repeat a few more times. Use two strings the same length. Do a few examples where both strings are wiggly, emphasizing that when the strings are wiggly we cannot really tell just by looking.

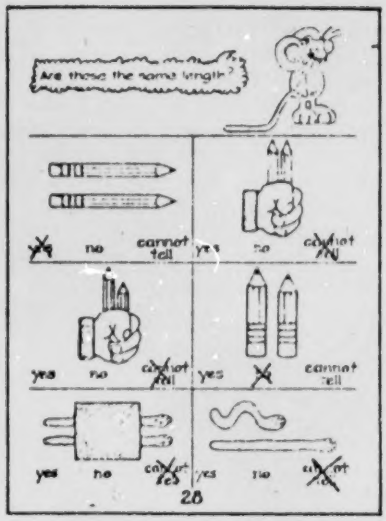
5. Use string to make two "snakes". Make one with two or three wiggles, cut the other string so it begins and ends evenly with the wiggly one. Cover the "snakes" with a piece of paper so that only the "heads" and "tails" are visible. Show the covered "snakes" to the class.

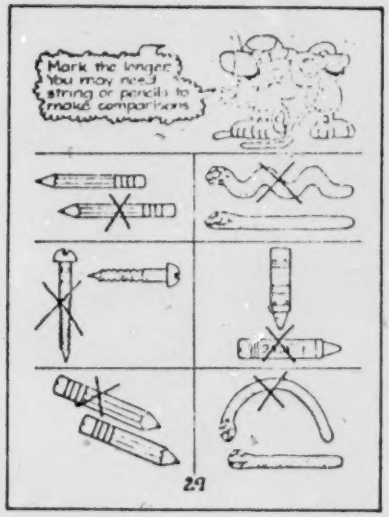
Point out that we see their heads even at one end and their tails even at the other end. Ask, "Do these snakes have the same length?" Discuss why you can or cannot tell for sure. Remove the paper to compare and explain that one snake is really longer than the other; stretch him out to show it.

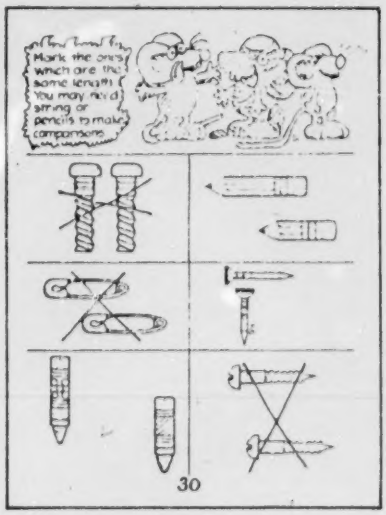
6. Do page 28 as a group. Students should mark "yes" if the objects are the same length, "no" if they are not the same length, and the "cannot tell" if they cannot tell.

7. Draw two lines on the chalkboard, one a little longer than the other and at right angles to one another.

Ask, "Which is longer?" Discuss ways the class can verify their guesses. They might cut a piece of string as long as one line and compare it to the other line. Or they might cut a piece of string for each line and compare the two strings. Then do pages 29 and 30 as a group, supplying students with string or strips of paper to make their comparisons. You might discuss how they could lay a pencil (or crayon) beside one picture and mark its length on the pencil with their fingers, then move the pencil to the other picture to compare.



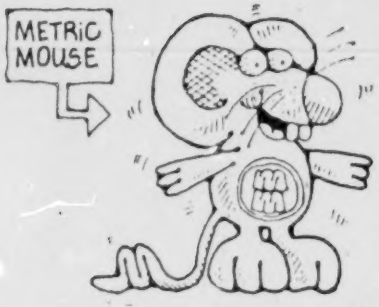



8. Pose the following problem to the class: Without moving my desk, can we tell if it will fit through the doorway? Show the class how to use a stick or piece of string to compare the width of the doorway to the width of the desk. Pose several other problems for the class to solve. Examples: will the bookcase fit under the window? Will the desk fit in between these tables?

# the 4th company

## section 6 · length: arbitrary units




Objectives: Given an arbitrary unit of length, determine the length of an object to the nearest unit.

Materials: 1 giant hand and 1 menehune hand per student (duplicated by teacher from patterns in the back of the Teacher's Guide), several meter sticks

Vocabulary: steps

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Illustrate how to use steps to measure distances. Then as a class activity, have children guess how many normal steps it will take to walk across the room. Walk in front of the class to demonstrate a normal step. Then ask, "If I walk across the room, how many steps will I take?" Write a few of their guesses on the board. Then step off the distance. Write your name and the number of steps on the board. Then let each child, one at a time, step off the distance. Have each student guess first, then walk; record each name and number of steps on the board. Discuss why answers differ. This will probably take the entire period, but it is a worthwhile activity. If each child guesses each time, their interest can be maintained. Expect childrens' guesses to be inaccurate at first. They should improve with practice.

2. Let one student pretend to be a menehune and step off the room in little steps. Let another pretend to be a giant and step off the room in large steps. If you wish, let students compete to see who is the biggest giant, i.e., who can cross the room in the fewest steps.

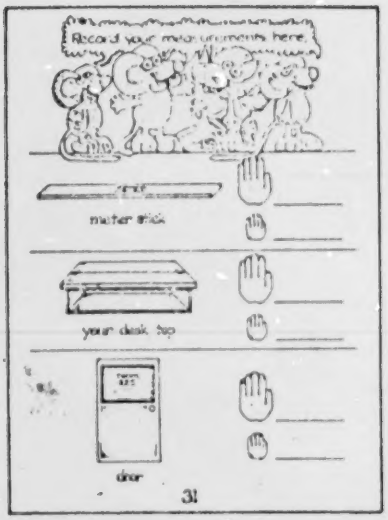
3. Duplicate and cut out enough giant and menehune hands to give each child one of each. Before distributing the hands to the students, ask, "How many hands long is my desk?" One at a time let students come forward to place a giant hand on the desk. Hands should be placed so that the arrows are in a straight line and the arrow heads are touching, but not overlapping. Count the hands and record the measure on the chalkboard. The measurement will probably not be exact. Therefore, use fingers on the giant hand to cover distances smaller than one hand ("the desk is about 9 giants hands and 2 fingers long"). Repeat the same procedure with at least two other lengths. For example, a student's desk, table, etc. Record these measures on the board (and save).

4. Put all but 2 hands back in the pile and ask, "Could we find the length of the desk if we only had 2 hands to use?" Try to get the class to suggest placing hands side by side and moving the hands (in leap frog fashion) to measure the desk, counting as they go. Let two students demonstrate. Hopefully you will get the same measure as before. Repeat with the same lengths used in activity no. 3.

5. Distribute one giant hand to each student. Let students work in pairs to measure a meter stick, their own desks, and the width of the door. They are to record their measures on page 31. Explain how to record on page 31.

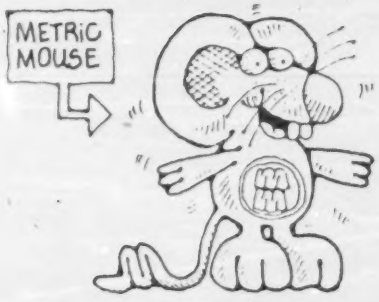
6. Now distribute one menehune hand to each student. Working in pairs the students should again measure the meter stick, their own desk, and the width of the door, this time using the menehune hands. They are to record their measurements on page 31.

7. Finally, ask, "What if we only had one hand to use?" Try to get the class to suggest placing one hand on the desk, marking the end of the hand in some way (such as by placing a finger), then replacing the hand beginning where the last one ended. Let a student demonstrate, keeping count. Repeat with the lengths used in activities 3 and 4. All students may not be able to measure accurately using this technique.



# the 4m company

## section 7 · length: meter · decimeter




Objectives: Given a meter, determine the length of an object to the nearest meter.

Given a decimeter, determine the length of an object (less than a meter) to the nearest decimeter.

Materials: meter stick marked in decimeters, adding machine tape, masking tape, decimeter strips (cut from the back of the Teacher's Guide)

Vocabulary: meter, decimeter

SUGGESTED PROCEDURES AND ACTIVITIES:

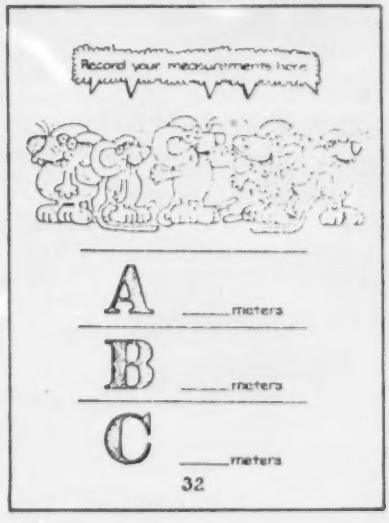
1. Review the previous lesson where children measured the room using their steps. Recall that the measurements differed. Ask, "How could we measure the room so that we all get the same number?" Discuss the need for a unit of measure which is always the same length and that everyone uses.

2. Introduce the meter as the unit that most people in the world use. Cut a meter strip from adding machine tape for each child. Ask, "How many meter strips would it take to go across the room?" Have pairs of children lay meter strips end to end across the floor. Make sure the ends are flush, without overlap, etc. Count the number of meters lying on the floor. Round off to the nearest meter. Expressions such as "about 9 meters", "9 meters and a little bit more", etc., are acceptable.

3. Then ask two students to measure the room using only <u>two</u> meter strips.

4. Then ask if anyone can measure the room using only <u>one</u> metre strip. Let 2 volunteers try to do this. Do not expect all children to use this technique well.

5. On the floor tape 3 different lengths of masking tape (3 m, 5 m, 7 m) and label them A, B, and C. Let students work in groups of 2 or 3 to measure the tapes and record their lengths on page 32.



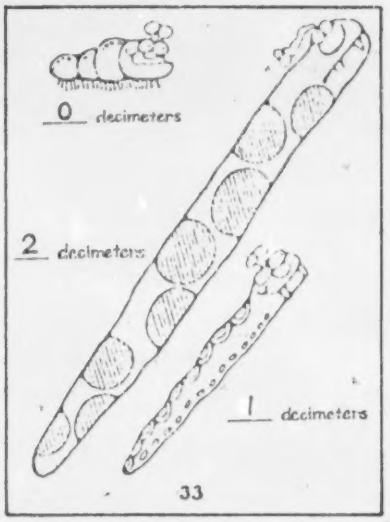
6. Tape a piece of masking tape three decimeters long on the floor. Ask a student to measure it using a meter stick. Since the distance is less than a meter, the meter is too large a unit. "The people who invented the meter had this same problem, and so they made a unit smaller than the meter. It is called a decimeter." Bring out some decimeter strips (cut from manual) and lay them end to end on the tape to determine its length.

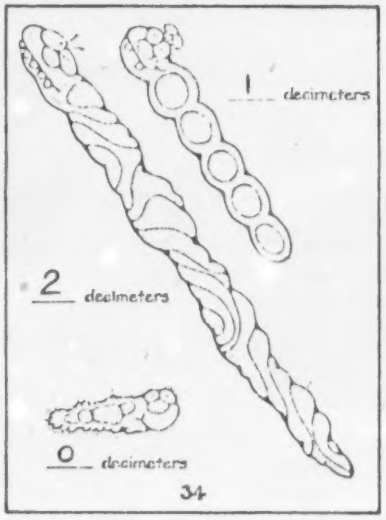
7. Review three ways to measure: using many decimeters placed end to end; using two decimeters in leap frog fashion; and using just one decimeter. Stress the need to be careful.

8. Draw 3 or 4 lines on the board for practice. Demonstrate how to use one decimeter to measure. Ask for estimates before measuring. Then lay one decimeter, mark its end with chalk, reposition the decimeter against the chalk mark, etc. Have several children try it at the board. Then assign pages 33-34. Do as a group. Have children estimate before measuring.

9. As a class demonstration use the meter stick marked in decimeters to show that 10 dm make a meter. Then demonstrate how to use that meter stick to measure in decimeters. While the class is resting or engaged in other activities, work with pairs of students. Have them count the number of decimeters in a meter on the meter stick. Review how to measure with the stick (in dm), then let each child measure several items in dm (lines or pieces of masking tape on the chalkboard).

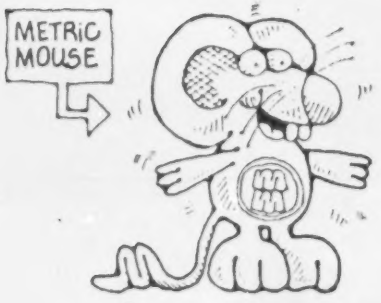
10. Summarize measurement with meters and decimeters. Meters are used for big things, decimeters for smaller things. Ten decimeters make a meter. Four different ways to measure: with many dm, with 2 dm, with 1 dm, and with a meter stick marked in dm. Reminder: measuring with a meter stick marked in decimeters is the culminating activity for length. Let children measure periodically throughout the year.



# the 4th company

## section 8 · heavier · heaviest : lighter · lightest




Objectives: Given two (three) physical objects and a balance, identify the heavier/lighter (heaviest/lightest).

Given an illustration of two objects on a balance, identify the heavier/lighter.

Given a balance and two physical objects, determine if they have the same mass.

Materials: balance; variety of things to compare including coins, gram and kilogram weights, styrofoam balls, steel balls, etc.; 3 empty milk cartons

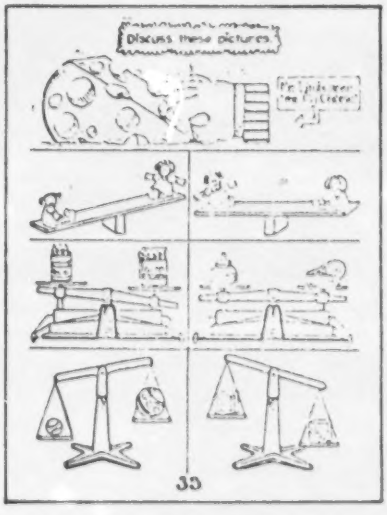
Vocabulary: heavier, heaviest, lighter, lightest, same mass

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Hold up two objects that vary in weight and place them on a balance. Explain that one is heavier because it makes the balance "go down" on its side. Place some objects on a table and have students, one at a time, guess by feel, then use the balance to determine the heavier of two objects.

2. Select an object and ask if someone can find a heavier object. Let several children participate, comparing the weights of various objects, including a gram and a kilogram.

3. Using a balance to demonstrate, discuss the six examples on page 35. Note that: 1) sometimes little things are heavier than big things; 2) sometimes neither object is heavier ("we say they have the same weight or mass") and the balance balances or stays even; and 3) even if things are the same size one may be heavier than the other. Make some specific comparisons to point these out. For example: large styrofoam ball and small steel ball, small steel cube and small aluminum cube, glass marble and same sized steel ball, two gram weights, two identical boxes with different contents.



4. Do pages 36-37 as a group.

5. Place three objects on a table and use a balance to find the heaviest. Write the word heaviest on the chalkboard (or on a card) and compare the words heavier and heaviest. Explain that for an object to be the heaviest one it must be heavier than each of the others. Compare the 2 heavier objects on a balance and ask the class which is the heavier between the two of them. Repeat the process explaining the meaning of heaviest again. Set out three new objects and demonstrate (or let a student find the heaviest). Repeat with different objects, letting several children participate.

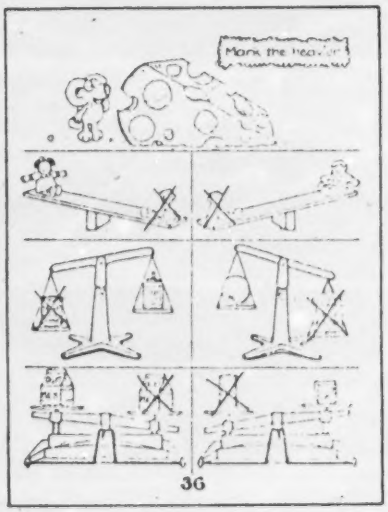
6. Repeat activities 1-5 using the concepts "lighter" and "lightest". Quickly review page 35 and do pages 38-39 as a group.

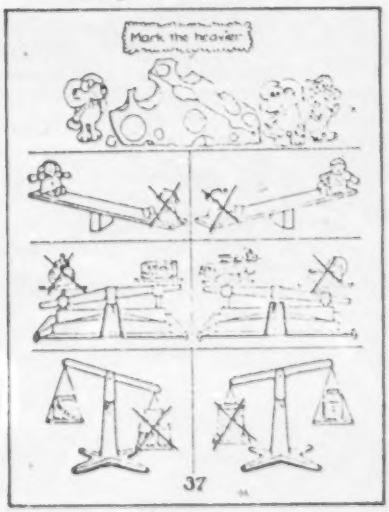
7. Before class prepare several pairs of milk cartons, at least one pair of which have equal masses. Let students work in groups to determine which pairs have the same masses.

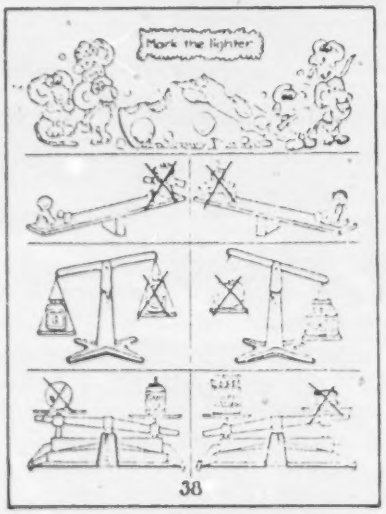
8. Get three things to weigh. Make sure each thing to be weighed has an identification number, letter, or tag. Have students come forward to arrange the objects in order from the lightest to the heaviest, just by feel. Without using the balance, discuss which objects are lighter. Check answers, using the balance.

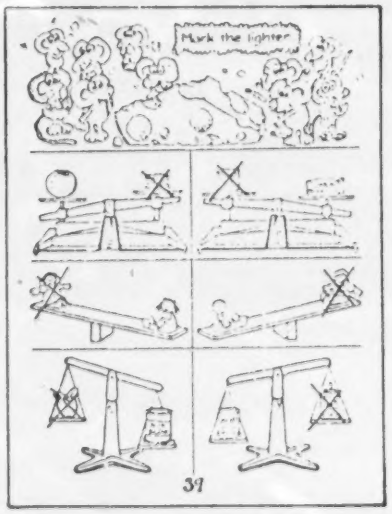
9. Children enjoy balancing coins, i.e. dime and nickel. You can talk about money values here.

10. As a group activity to be done many times throughout the year as reinforcement, place 3 items which vary in weight in closed boxes or milk cartons. Ask a student to arrange them from lightest to heaviest. Give each student a chance to do this sometime. Change objects, of course.



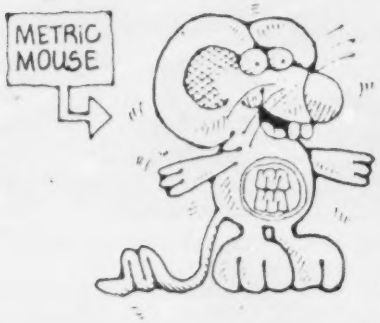



# the 4th company

## section 9 · mass(weight): arbitrary units · gram · kilogram




Objectives: Given a balance and 1-gram weights, determine the mass (weight) of a small object.

Given a balance and a 1-kilogram weight, determine if an object is heavier/lighter than one kilogram.

Given the names of three common objects which differ greatly in mass, identify the heaviest/lightest.

Materials: balance; wooden blocks (or nickels or metal washers) to use as arbitrary weights; 1-gram weights; kilogram weight; a variety of things to weigh; for page 40 a pencil, an eraser, and a penny; for page 41 a shoe, five 1-gram weights, and a quart milk carton filled with sand and stapled shut; flashcards (pages 43-45)

Vocabulary: weighs more, weighs most, weighs less, weighs least, mass, weight, gram, kilogram

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Discuss what it means when the balance balances - that the 2 objects being compared have the same mass (weight) or weigh the same, neither is heavier nor lighter.

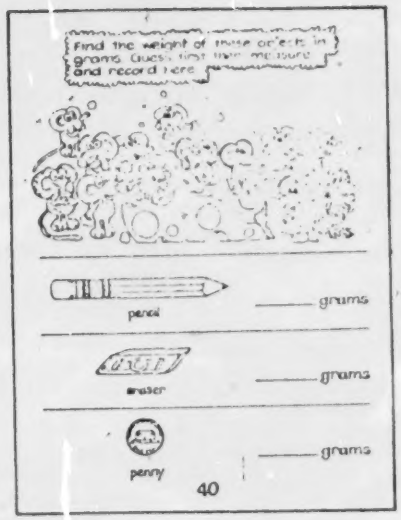
   Guessing game: Have individual students guess the number of blocks (or nickels or metal washers) it would take to balance a given object. Write several guesses on the chalkboard. Then use the balance and blocks to find out the correct number. Record the answer on the chalkboard. Erase the guesses and repeat giving another object to balance. Do not expect accurate estimates at first.

   glue - 8 blocks
   tape - 4 blocks

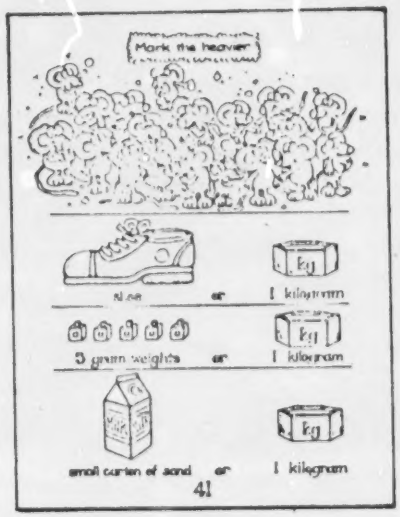
   Point out on the chalkboard record the number of blocks it took to balance each item. Ask, "Which object took more blocks to balance?" Explain, "That means the glue 'weighs more' than the tape." Ask, "Which object took less blocks to balance?" Explain, "That means the tape 'weighs less' than the glue." Repeat the game, keeping records. Discuss which item "weighs most" and which "weighs least" of all that you used. Discuss and use the records of the Guessing Game to demonstrate: "Do 'heavier' and 'weighs more' mean the same?" etc.

2. Introduce the gram weight. Explain that the gram is a unit of weight (mass) in the Metric System. Instead of using wooden blocks to weigh things, we use grams. Explain that each cube has a mass or weight of one gram and let everyone feel how heavy one gram is. Demonstrate how to weigh an object in grams using the balance and the gram weights. Use several small objects in the demonstration, asking one or more students to feel the object then guess how many grams the item weighs before they weigh it for the class.

3. Get a pencil, an eraser, and a penny. Use page 40 to give everyone an opportunity to use the balance and weights. While other students are resting or working (coloring) have 3 students at a time come to the balance and each weigh an item, recording the weights on page 40. Supervise each student's weighing technique, reminding them of the manual damper (if your balance has one), and to stand directly in front, rather than to the side, of the needle to check its position. Before a student weighs an item have each of the 3 students hold it and guess how many grams it will be. Guesses will be very inaccurate at first but should improve with practice.




4. Introduce the kilogram weight. Explain that we use the gram to weigh light things and the kilogram to weigh heavy things. Let each child hold the kilogram weight. Let the class try to find objects heavier and lighter than a kilogram. Check on a balance. Do page 41 as a group. You will need a balance, a kilogram weight, a shoe, a quart milk carton filled with sand and stapled shut, and five 1-gram weights. Summarize by discussing which unit of weight is used to weigh heavy things and which is used to weigh light things. Ask which unit we use to weigh people.

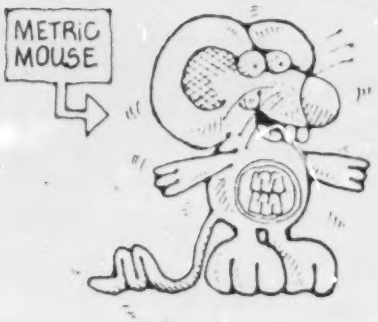



5. Cut out the eight flashcards that pertain to the concepts "heavier" and "lighter", "weighs more" and "weighs less" (from the back of the Teacher's Guide). Use these and the cards for previous sections for periodic review throughout the school year.

6. Call out the names of three common objects which differ greatly in mass. Have students identify the heaviest (or lightest). Examples: mouse, book, man; toothpick, kilogram weight, elephant.

# the 4th company

## section D · conservation of mass (weight)




Objectives: Given two equal masses, state that the masses remain equal when changed into different shapes. (Mastery not expected of all children at this age level.)

Materials: balance, modeling clay or Play Doh

Vocabulary: weighs more, weighs less, heavier, lighter

SUGGESTED PROCEDURE AND ACTIVITIES:

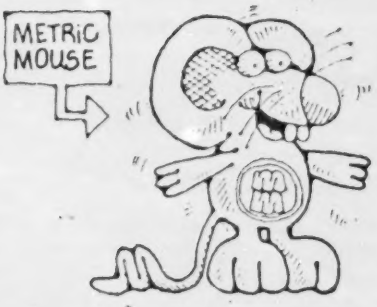
1. Balance two lumps of clay on a balance. (Pinch off one, add to the other until they balance.) Have everyone agree that the two lumps weigh the same. Then roll one into the shape of a long sausage. Ask: "If I put both lumps of clay back on the balance, will one be heavier?" They will weigh the same, of course. Let children try to explain why they still balance. Then explain that the shape of an object does not determine its weight. Optional: After forming two lumps that balance, remove both from the balance scale and give one lump to the boys and one lump to the girls. Let each group try to make "a heavier shape" than the other. Caution them not to take any clay away nor to add anything to their lumps of clay, but only to reshape it. Compare the two new shapes which should balance as well as the original shapes. Discuss.

2. Then divide one lump into four or five lumps. Ask which side will be heavier. Check it on the balance. Discuss. Repeat with various shapes.

3. Cut an apple in half and trim the pieces until they balance. (Trimming should be done before class and any necessary last minute paring can be done quickly in class.) Show the class that the apple halves balance. Ask what would happen if you cut one half in half again. "Would they still balance, the half and the other half cut in two?" Cut it and check it on the balance. Continue cutting and checking as interest dictates. (Provided the apples are not very juicy, all should go well. If they don't balance discuss reasons why not, loss of juice during cutting or due to evaporation, for example.)

# the 4th company

## section II · holds more · most : holds less · least




Objectives: Given two (three) containers, identify the one which holds more/holds less (holds most/holds least).

Given an illustration of two (three) containers, identify the one which holds more/holds less (holds most/holds least).

Given the names of three common objects which differ greatly in capacity, identify the one which holds most/holds least.

Materials: a variety of containers of different shapes and sizes (include a liter and a deciliter), water (colored water is desirable), plastic dishpan (recommended to contain spills); flashcards (from back of Teacher's Guide)

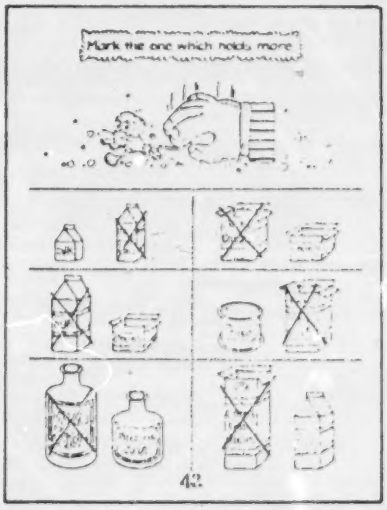
Vocabulary: holds more, holds most, holds less, holds least, fewer, fewest

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Select two clear containers, one obviously larger than the other. Pointing to the larger say, "This container 'holds more'." Then fill the smaller with water and empty it into the larger. Explain that since there is still empty space in the larger container, this means it holds more water than the smaller container. Empty both, and fill the larger container. "What will happen if I try to pour all this water into this container?" (Point to the smaller container.) Hopefully the children will say "it will spill" or "it won't all fit". Then pour from the larger to the smaller container, showing that there is some water left over. Explain that this also means the larger container "holds more" water.

2. Use a variety of containers and compare two at a time. Let a student come forward and guess which one "holds more". Supervise as the student fills one and pours it into the other to check. (Pouring over a plastic dishpan on the demonstration table will help cut down on clean-up afterwards.)

3. If available, display containers of various shapes. Discuss the difficulty of determining which container holds more just by looking at them. Let students suggest that some containers are tall but "skinny" and others are short but wide or big around. Do page 42 as a group, discussing each picture.



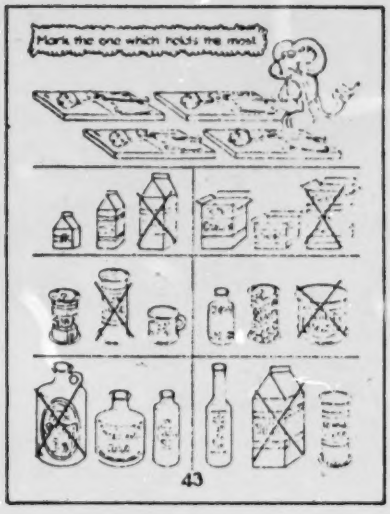
4. Set out 3 different sized containers. As a class activity decide which holds the most by pouring. Fill what you think is the large one, pour into a smaller one. If there is water left, it is the larger. Repeat to find the largest. Explain that the container which holds the most holds more than each of the others. We use "more" when there are only two containers to compare and "most" when there are three or more.

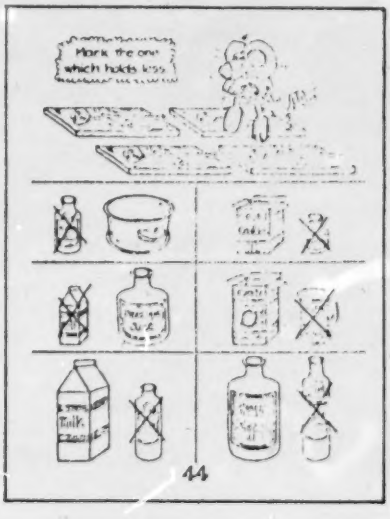
5. Do page 43.

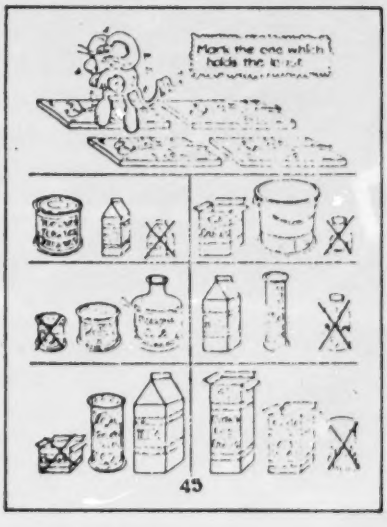
6. Repeat activities 1-5 using the concepts "holds less" and "holds least". Use pages 44 and 45 in the workbook.

7. Call out the names of three things which hold liquid. Have students identify the one which holds the most (or least). Examples: swimming pool, bathtub, coffee cup; teaspoon, pitcher, gasoline truck; aquarium, drinking glass, milk carton.

8. Turn to the back of the Teacher's Guide and cut out the eight flashcards that pertain to liquid capacity. Use these cards throughout the year for drill.

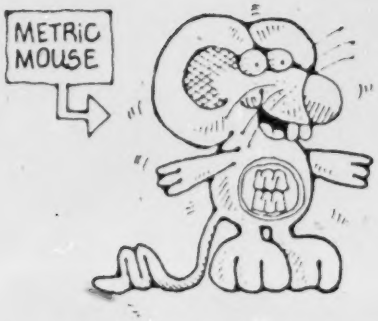


# the 4M company

## section 12 · conservation of liquid




Objectives: Given two equal amounts of liquid, state that the amounts remain equal when one of them is poured into a different-shaped container. (Mastery not expected of all children at this age level.)

Materials: 2 identical containers (baby food jars are good), one tall thin container (stuffed olive jar is good), other containers, water (colored water is desirable)

Vocabulary: more, less, same amount

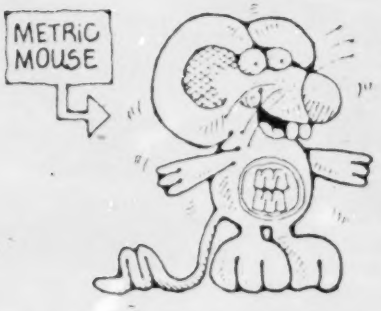
SUGGESTED PROCEDURE AND ACTIVITIES:

1. Fill two containers with water so that they hold the same amount. Get the class to acknowledge that there is the same in each container, then pour the contents of one into the third container. Ask, "Now do we have the same amount of water or does one container have more water?" Discuss, then pour the water back.

2. If you have other containers, shorter wider ones as well as taller narrower ones, repeat the procedure several times. Permit children to pour the water themselves.

# the 4M company

## section 3 · capacity: arbitrary units · liter · deciliter




Objectives: Given a unit container (arbitrary, liter, or deciliter), determine the capacity of a container to the nearest unit.

Materials: a variety of containers; a small cup; deciliter measure; liter measure; bucket (pitcher, jar, etc. to measure in liters); for page 46 an empty quart milk carton, an empty half gallon milk carton, and an empty gallon jug (bleach bottle); for page 47 an empty half-pint milk carton, an empty soda can, a liter measure; water, funnel and plastic dishpan recommended to catch spills

Vocabulary: liter, deciliter

SUGGESTED PROCEDURE AND ACTIVITIES:

1. The teacher should demonstrate before the class how to use a smaller container to fill a larger container. Caution students to always fill the smaller container to the top, or to the same mark, to keep their measurements consistent from person to person. Compare the capacity of two large containers by counting the number of cups it takes to fill each.

   On the chalkboard record the number of cups it takes to fill each container. Ask students which container "holds more" and which "holds less". Measure a third container and record. Ask students which "holds the most" and which "holds the least". Optional: Measure a few more containers as above and record. Then have students arrange all the containers from left to right from the one that holds the fewest cups to the one that holds the most.

2. Introduce the liter. Explain that it is used all over the world to measure liquids such as milk and gasoline. Set out a bucket. Ask children to estimate how many liters it will take to fill the bucket. Record several guesses on the board. Then let a child experiment to find out how many liters will fill the bucket. Do the same with a pitcher, a jar, etc. Caution students to always fill the liter measure just to the liter mark.

3. Do page 46 as a class. You will need an empty gallon jug (bleach bottle, for instance) and two empty milk cartons -- one quart-sized and one half-gallon-sized. On each carton cut exactly at the top crease and remove the tops. Hold up the smaller carton and ask children to guess how many liters it holds. Then have one child come forward and measure how many liters it takes to fill the carton. Everyone should record that number on page 46. Ask, "Do you drink one liter of milk for lunch, or more than a liter, or less than a liter?" (Fill a drinking glass and pour that into a liter measure to illustrate your question.) Have children guess then measure the

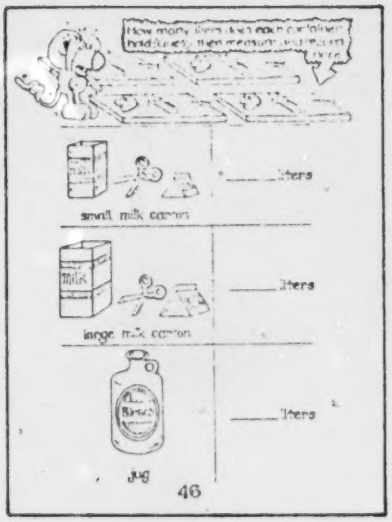
The next 4 activities are designed to allow every child in the class to have at least one supervised measuring experience.

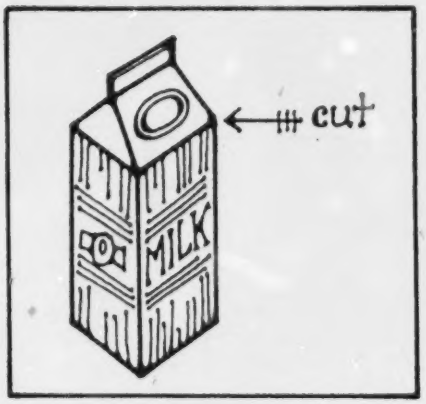
capacity of the large milk carton. Ask, "When your mother buys milk does she buy the carton that can hold one liter or the carton that can hold two liters?" Guess then measure the capacity of the jug. A funnel would be useful here.

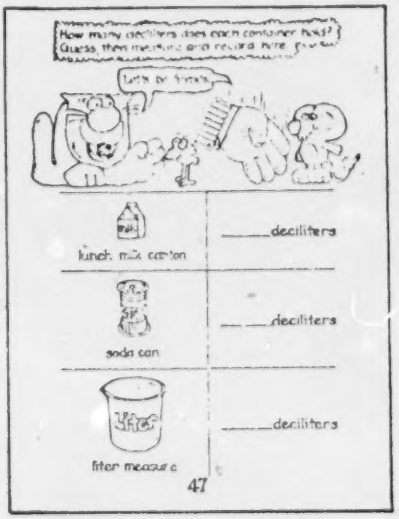
4. Now set out a deciliter measure. "This container holds one deciliter of liquid." Explain that the deciliter is used to measure containers smaller than a liter. Hold up a liter container and ask which holds more, which holds less. Ask students to guess how many deciliters it would take to fill a liter. Record the guesses. Let a student experiment, making sure he fills the deciliter measure each time to the 1 deciliter mark. Set out several jars and repeat guessing and measuring with deciliters, letting different children get experience measuring.

5. Ask, "Do you drink a deciliter of milk at lunch? How many deciliters do you think your lunch milk carton holds?" Turn to page 47 and do it as a class. You will need a deciliter measure, an empty half-pint milk carton, an empty soda can, and a liter measure.

6. Verify that 10 deciliters is the same amount as 1 liter.

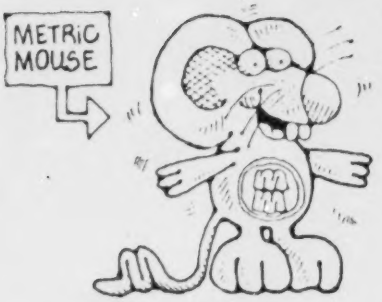


# the 4M company

## section 14 · temperature




Objectives: Given two glasses of water whose temperatures vary, identify the warmer/cooler (hotter/colder).

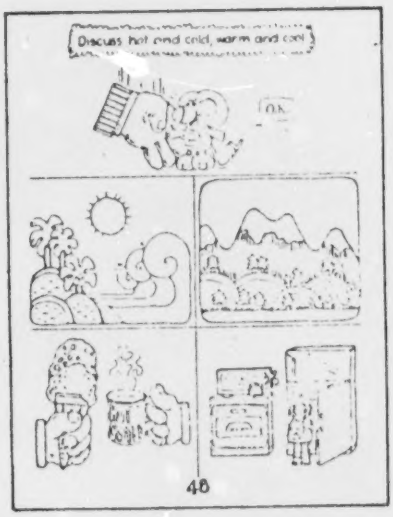
Given illustrations of two thermometers, identify the hotter/colder.

Materials: glass of warm water, glass of ice water, thermometers, demonstration thermometer (if available); flashcards

Vocabulary: warmer, hotter, cooler, colder, thermometer, temperature

SUGGESTED PROCEDURE AND ACTIVITIES:

1. Discuss temperature. Things that are hot or warm, things that are cold or cool - milk at lunch time, soda, ice cream, fire, coffee, etc. Talk about cold (cool) places and hot (warm) places. Do page 48 as a group.

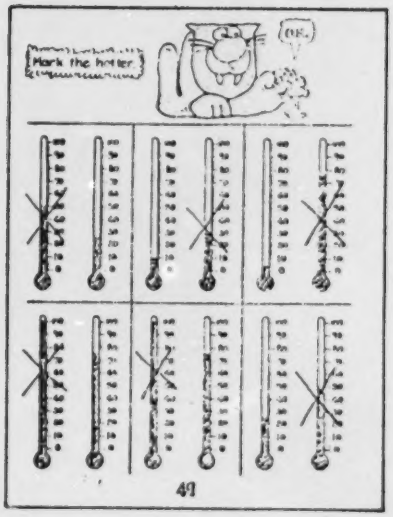


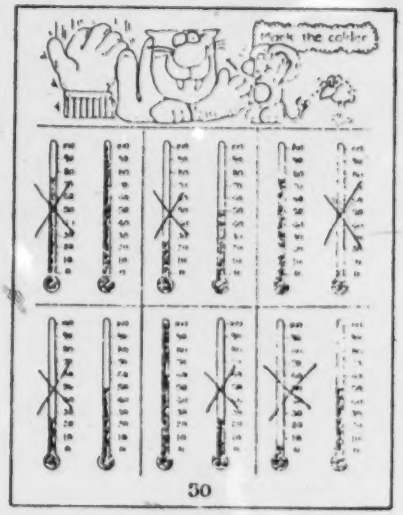

2. Fill 2 glasses with water that varies in temperature. Let each student try to guess which is cooler (colder) and which is warmer (hotter) by touch.

3. Explain how a thermometer works: The higher the red (or silver) fluid, the hotter, etc. Place a thermometer in ice water and let the class watch the red fluid go down. Then place another thermometer in hot or warm water. Compare the heights of the red liquid. Discuss and explain. Let children verify this for themselves if there is time.

4. Do pages 49-50.

5. See the back of the Teacher's Guide for flashcards on "warmer", "cooler", "hotter", and "colder".



41

SECTION 2,3,4,7. Decimeter strips.

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42

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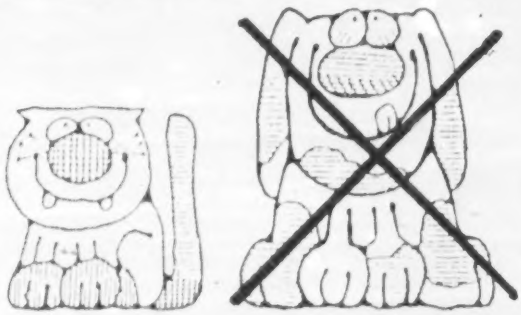
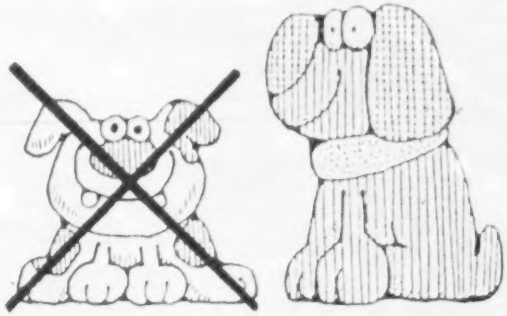
SECTION 6. Giant hand and menehune hand. Duplicate and cut out enough hands to give each child one of each.

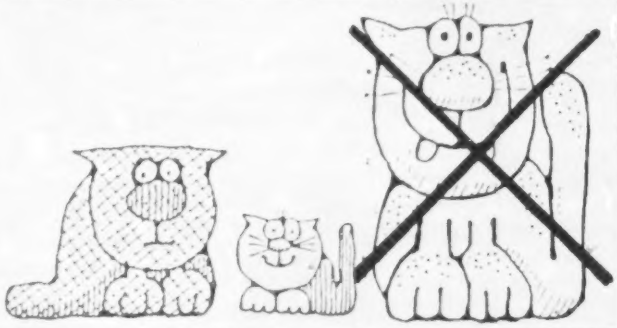
43



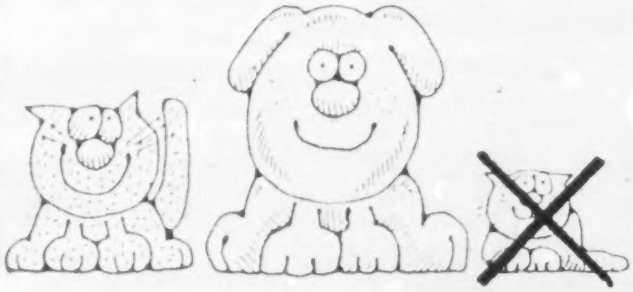
larger



smaller



largest



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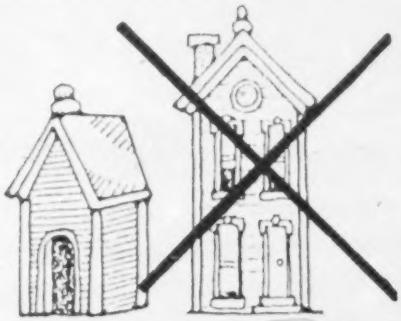
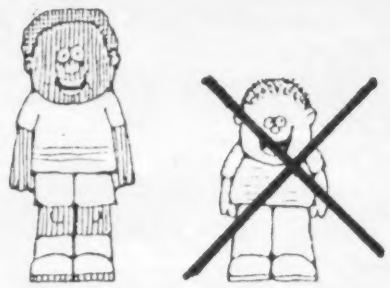


taller



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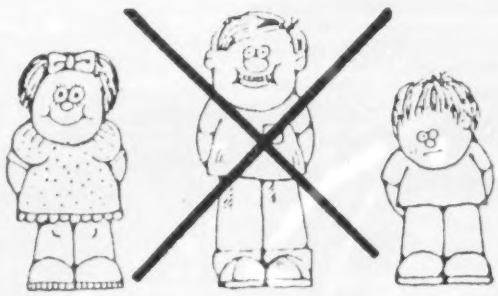

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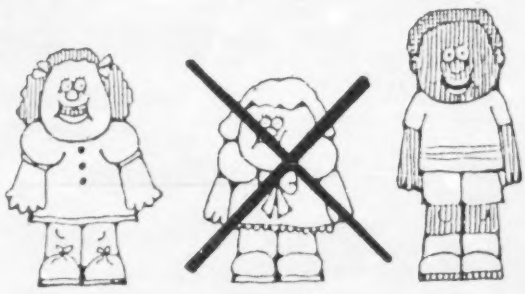

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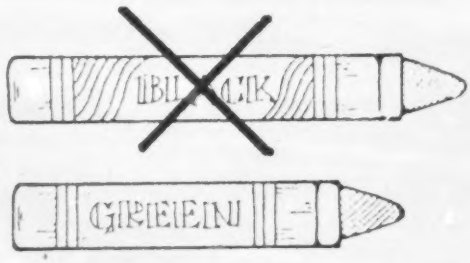

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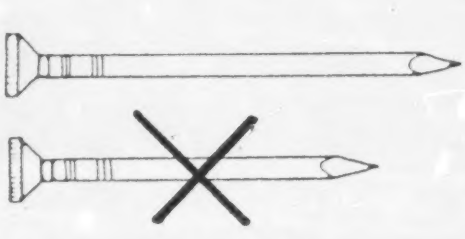

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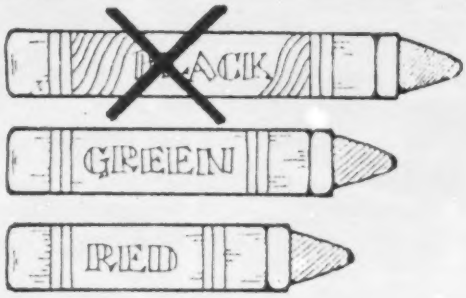


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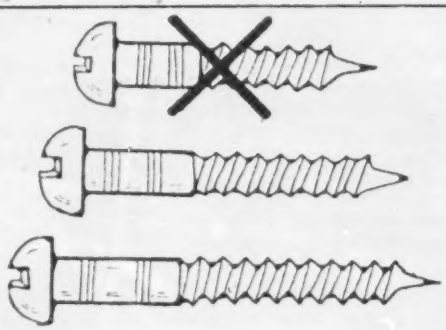

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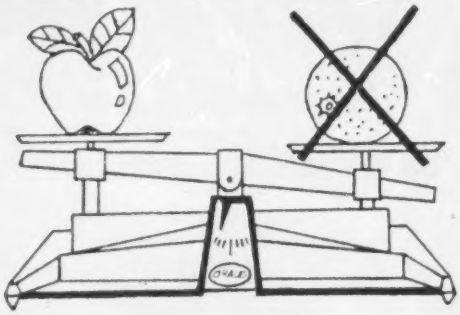
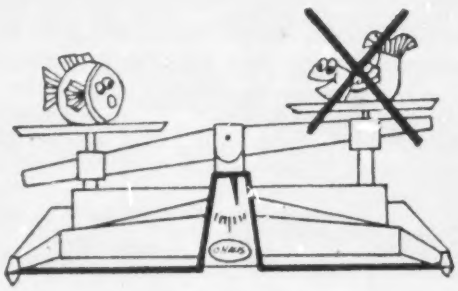
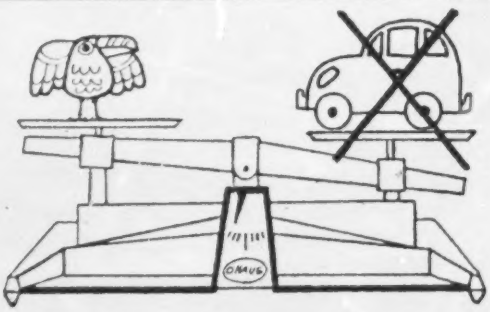


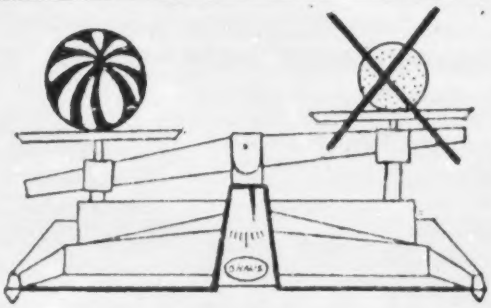
heavier



lighter



weighs more



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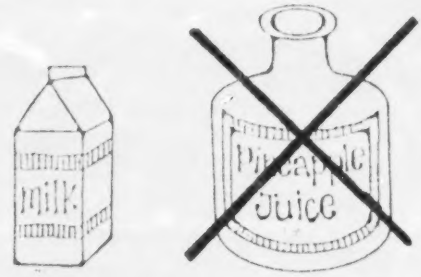
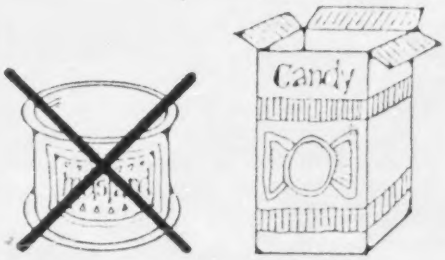



holds more




holds less

holds most

holds least

| | |
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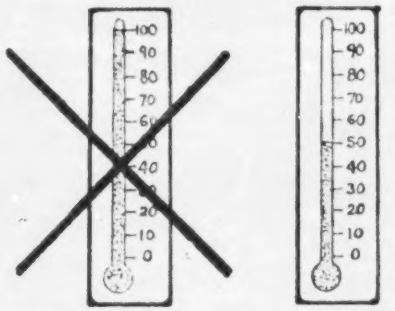
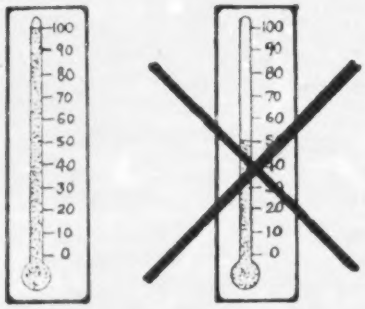
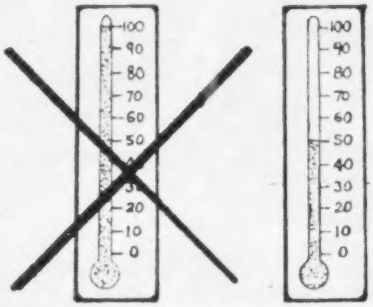
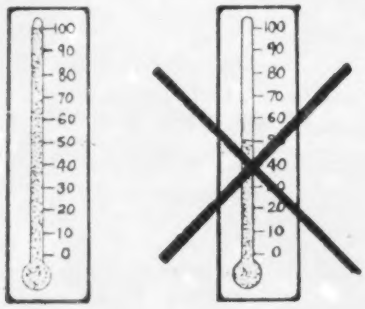
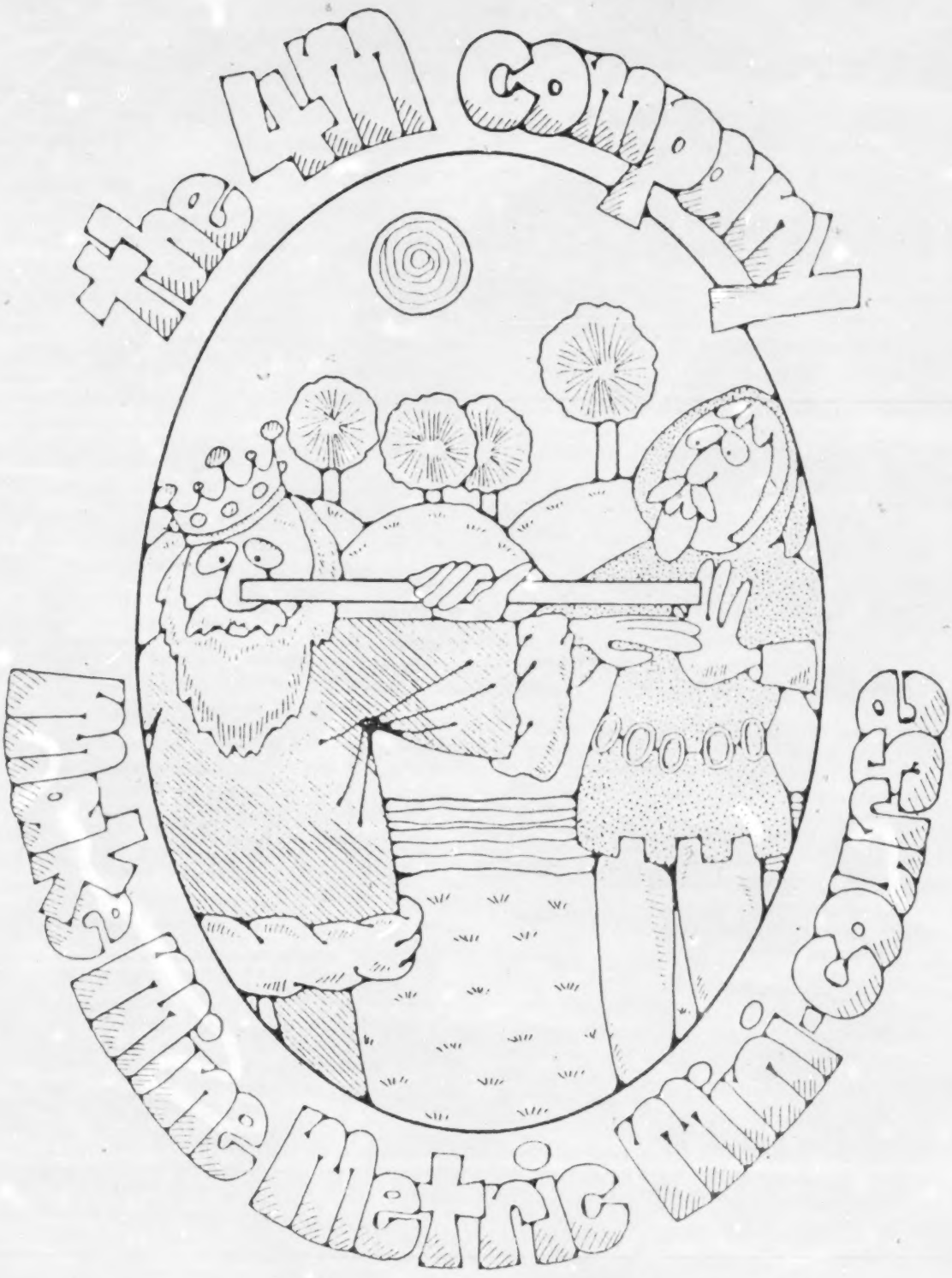
|  | hotter |
|  | colder |
|  | warmer |
|  | cooler |

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## INTRODUCTION

This mini-course is designed to serve two purposes: 1) a quick review of metrics for teachers who have attended a metric workshop; and 2) a basic introduction to the metric system for teachers who have not attended a metric workshop. If studied seriously, we feel the contents of this mini-course can prepare a teacher to teach the metric system. However, don't expect to be an expert right away. Even teachers who have attended a workshop frequently forget much of what they learned. As most teachers know, we usually don't know a subject well until we have taught it a time or two. The same will be true of metrics.

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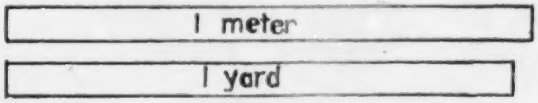
## LESSON 1: THE METER, THE LITER, AND THE GRAM

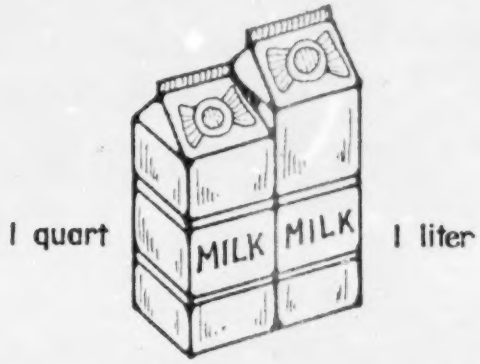
The three most common metric units are the meter (for measuring length or distance), the liter (for measuring liquid or granular capacity), and the gram (for measuring weight). Select a meter, a liter, and a gram from your metric supplies.

The meter is the main unit of length in the metric system. Stand up and hold the meter stick on the floor against your leg. How high up your leg does it come? To your hip? To your waist? Remember the spot and you'll always have some idea of a meter. A meter is just a little longer than a yard -- 39.36 inches.




The liter is the main unit of capacity in the metric system. It was originally defined to be the capacity of a cube each of whose sides was 1/10th of a meter long.

Take a good look at the liter. Does it appear to be about the size of any English unit? Actually, the liter is slightly larger than a quart (6% larger, to be exact).




Now pick up the gram, the main unit of weight in the metric system. Pretty light, isn't it? If you look at the protein, fat, and carbohydrate content of the sides of cereal boxes you'll notice that the weights are given in grams. A paper clip weighs about one gram. A nickel weighs 5 grams.

weighs 1 gram

weighs 5 grams

These three units - meter, liter, and gram - are the heart of the metric system necessary for everyday measuring. Try to remember the size of each unit: the meter is a little longer than one yard; a liter is a little larger than a quart; and a gram is the weight of a paper clip.

## LESSON 2: OTHER UNITS - PRESTO!

In the English system of measurement there are 14 units of length, and there is no systematic relationship between them:

12 inches = 1 foot

3 feet = 1 yard

5½ yards = 1 rod

40 rods = 1 furlong

8 furlongs = 1 mile

etc.

One would have to be a near-genius to remember all the relationships in the English system!

By comparison, the metric system is simple (although it may not seem so at first). In the metric system there is one base unit for each physical property to be measured. To form units larger or smaller than the base units, a system of prefixes, each of which is a power of ten, is used. For units smaller than the base units, the Latin words for tenth, hundredth, and thousandth are used (deci, centi, and milli). To form units larger than the base units, the Greek words for ten, hundred, and thousand are used (deka, hecto, and kilo). The new units are formed by placing the prefixes in front of the base units.

| | LENGTH | CAPACITY | MASS (WEIGHT) |
|---|---|---|---|
| 1000 | kilometer (km) | kiloliter (kℓ) | kilogram (kg) |
| 100 | hectometer (hm) | hectoliter (hℓ) | hectogram (hg) |
| 10 | dekameter (dam) | dekaliter (daℓ) | dekagram (dag) |
| 1 | meter (m) | liter (ℓ) | gram (g) |
| 0.1 | decimeter (dm) | deciliter (dℓ) | decigram (dg) |
| 0.01 | centimeter (cm) | centiliter (cℓ) | centigram (cg) |
| 0.001 | millimeter (mm) | milliliter (mℓ) | milligram (mg) |

Whenever kilo is heard, we know immediately that we have 1000 of the base unit, whatever it is. Thus, kilometer is 1000 meters, kiloliter is 1000 liters, kilowatt is 1000 watts, etc. (The watt is a unit of power.) Or, millimeter is 0.001 meter, milliliter is 0.001 liter, etc.

The writing of metric units is simplified by the use of symbols: m stands for milli, c for centi, d for deci, da for deka (the a is needed to distinguish deci from deka, both of which start with d), h for hecto, and k for kilo. Also, m for meter, ℓ for liter, and g for gram. Thus kg is kilogram, mℓ is milliliter, etc. In the next lesson you will practice using these metric prefixes.

## LESSON 3: PRACTICE WITH PREFIXES

In this lesson you will practice using metric prefixes. Use the table in Lesson 2 to help you complete the following equations. Answers appear at the end of the Teacher's Guide.

| | | | |
|---|---|---|---|
| 100 grams = | hectogram | 100 liters = | |
| 10 liters = | | 1000 liters = | |
| 1000 meters = | | 1000 grams = | |
| 0.001 gram = | | 10 meters = | |
| 100 liters = | | 0.1 meter = | |
| 0.01 gram = | | 0.1 liter = | |
| 0.001 meter = | | 0.01 liter = | |
| 0.01 meter = | | 0.1 gram = | |
| 0.001 liter = | | 10 grams = | |

Keep going! Try these!

10 cards = dekacards (get it?)

0.1 Arnaz = _____

0.01 mentalist = _____

1000 manjaros = _____

0.001 tary = _____

0.1 mate = _____

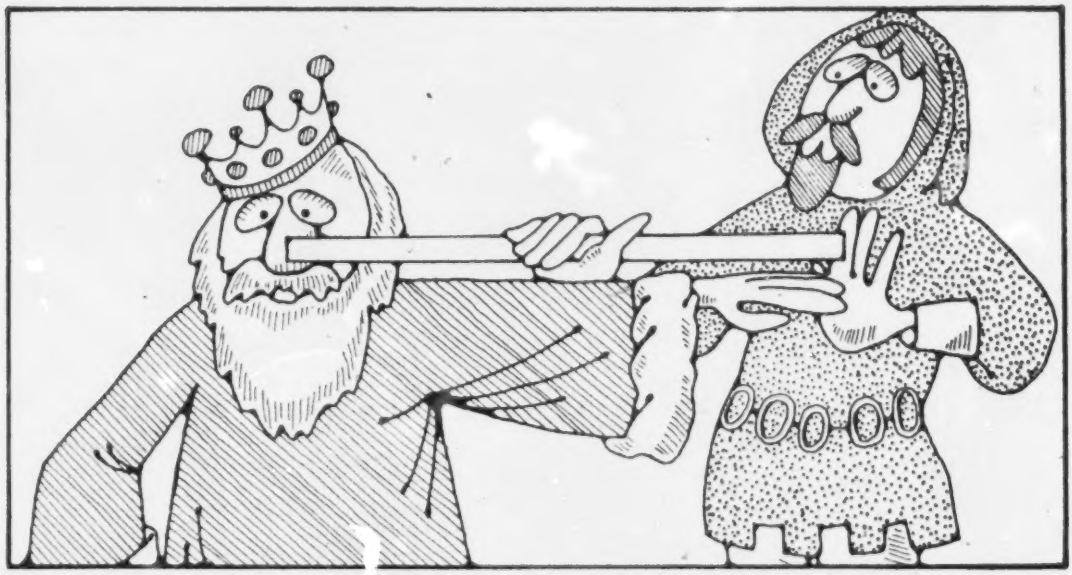
1000 whats? = _____

0.001 scent = _____

0.01 pede = _____

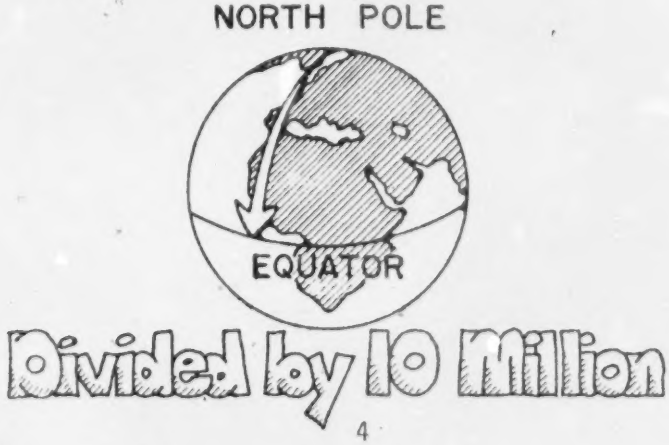
LESSON 4: A BRIEF HISTORY OF THE METRIC SYSTEM

Prior to 1790, the measurement systems of Europe were based on arbitrary objects: an inch was once defined to be the length of 3 kernels of barley corn placed end-to-end; a rod was the combined left feet of the first 16 men coming out of a specific church on Sunday morning; an acre was the amount of land a team of oxen could plow in one day; the yard was the distance from the tip of King Henry I's nose to the tip of his extended middle finger; etc.

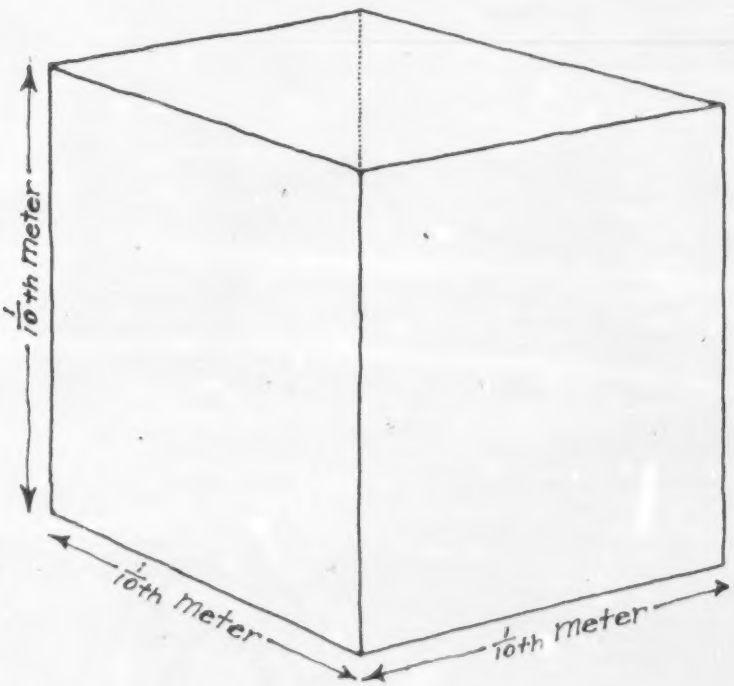


A similar hodge-podge of units was used in France at the time of the French Revolution. In 1789, the French Academy of Sciences was requested by the National Assembly to devise a new measurement system. The French Revolution was underway, and because of the antiaristocratic attitude of the French people, a change to a system not based on dimensions of royal monarchs was highly acceptable to them.

In developing the metric system the French scientists had three major objectives. The first objective was to find a unit of length that was measurable and reproducible everywhere, and natural in the physical world. To meet this objective, the meter was defined to be one ten-millionth of the distance from the equator to the north pole.

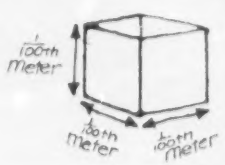


The second objective was to relate the unit of length to other units of measurement. For the main unit of capacity they selected a cube, with each of its sides equal to 1/10th of a meter (cubic decimeter), and called the amount of space contained within this box-shaped figure a "liter."




Liter

For the main unit of mass, the French scientists took a cube with each of its sides equal to 1/100th of a meter (a cubic centimeter), filled this box with pure water at 4° Centigrade, and designated the mass of this water as a "gram." Thus, the meter was used to define both the liter and gram.




Gram

The third objective was to simplify the conversion from one unit to another. We have already seen how a system of prefixes, which are powers of ten, was used to accomplish this objective. Since each metric unit is ten times larger than the next smaller unit, converting from one unit to another can be accomplished by merely moving a decimal point. Thus

35 meters = 0.035 kilometers
0.35 hectometers
3.5 dekameters
350 decimeters
3500 centimeters
35 000 millimeters

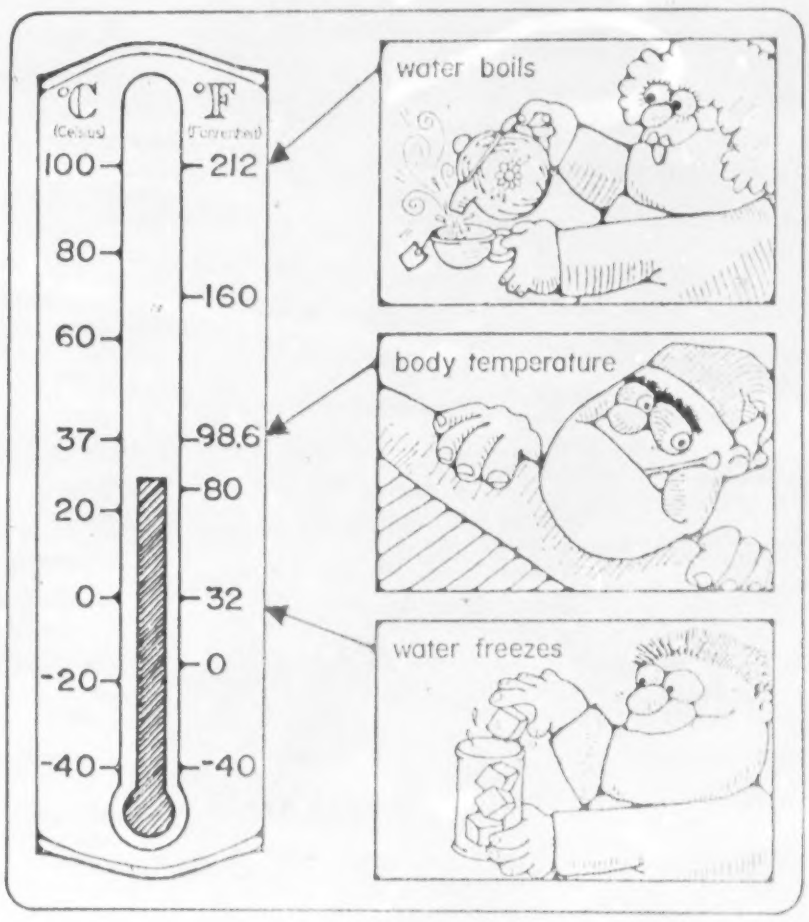
Scientists adopted the metric system immediately, for it made their work much simpler. Nations, on the other hand, have been slow to adopt it. It wasn't until 1840 that the French government made its use mandatory. By 1900, thirty-five nations had officially adopted it, and by the middle of this century, the main holdouts were the English-speaking nations. In 1965, England joined the European Common Market. Since Europe used the metric system, England decided to go metric. The other English-speaking nations soon followed. Ten years later, President Ford signed the Metric Conversion Act of 1975. Finally, after 180 years, the conversion to metric is nearing completion.

## LESSON 5: TEMPERATURE

There is one more metric unit which is encountered in daily living, the unit for temperature, degree Celsius (pronounced sell-see-us). Most adults are surprised to learn that "degree Centigrade," which they vaguely remember from their school days, has been changed to "degree Celsius."

The change came about in 1948, at the General Conference on Weights and Measures which convenes periodically to review and ratify measurement standards. A debate arose concerning the name of a unit for metric temperature. Some conferees favored the English "degree Centigrade," and others favored the French "degré centisimal". By coincidence, the centigrade scale had been invented by Anders Celsius. Since his last name started with "C," his name was selected as a compromise.

The Celsius scale is simpler than the Fahrenheit scale. The drawing below illustrates its simplicity. Water boils at 100°C and freezes at 0°C. If you can remember the four temperatures shown on the thermometer, you'll have a good beginning on making sense of the Celsius scale.



## LESSON 6: MASS (WEIGHT?)

The purpose of this lesson is to explain the difference between mass and weight. The kilogram is the unit of mass, and the Newton (after Sir Isaac Newton) is the unit of weight.

If you were an astronaut in outer space, the objects in your space craft would have very little weight. If you held a bowling ball in your hand and released it, it wouldn't fall. It would remain suspended in space. If the bowling ball were placed on a scale, it would read zero. It would be weightless. Why? Because the bowling ball is so far from the earth that it has escaped the pull of the earth's gravity.

Weight, then, is a measure of gravitational pull on an object. The weight of an object can vary, depending on where it is in the universe.

The mass of an object never varies. It is the same on earth as anywhere else in the universe. Mass is a measure of how much matter an object contains. The bowling ball is weightless in space, but it still has the same mass. Because of its mass, if you kicked it with your bare foot it would still hurt, whether you were on earth or in a spaceship.

We determine the weight of an object by spring scales which measure the downward pull on an object placed on it. This downward force is measured in Newtons. The mass of an object, on the other hand, is determined by using a balance: the object is placed on one side and balanced with standardized mass pieces. This is what a pharmacist does when he mixes a compound.

However, the mass of an object is directly proportional to its weight on earth. That is, a one-kilogram mass has a weight of about 9.8 Newtons at sea level; a two-kilogram mass has a weight of about 19.6 Newtons; etc. Thus, either mass or weight gives us a good measure of how much matter an object contains. Therefore, in everyday usage spring scales are used for determining mass in kilograms because it is much more convenient than using a balance. The 4M COMPANY uses the words interchangeably - mass (weight). For everyday usage, the distinction is unimportant.

## LESSON 7: SI

The French scientists made several errors in their original calculations. For example, they miscalculated the distance from the equator to the north pole by about 2000 meters, and instead of being equal to one cubic decimeter, the liter was actually equal to 1.000028 cubic decimeters.

To correct these errors, various scientific organizations of the world met in 1960 to devise a modern metric system which is called the International System of Units (or SI for short, after the French Le Systéme Internationale d'Unités). SI was created to meet the exacting demands for precise scientific measurement. Most of the units and prefixes will not be used by the average citizen. But for the sake of completeness, we include a list of the base units and all the prefixes.

### BASE UNITS

| Quantity | Name | Symbol |
|---|---|---|
| length | meter | m |
| mass | kilogram | kg |
| time | second | s |
| electric current | ampere | A |
| thermodynamic temperature | kelvin | K |
| amount of substance | mole | mol |
| luminous intensity | candela | cd |

Two units not on the list above are commonly used with the metric system. Instead of referring to liquid capacity in terms of cubic decimeters, the liter is used. And instead of using the Kelvin for temperature, degree Celsius is used (the Kelvin scale was derived from the Celsius scale).

### PREFIXES

| Prefix | Symbol | Pronunciation Symbol | Multiples & Fractions |
|---|---|---|---|
| exa | E | ex´ah | 1 000 000 000 000 000 000 |
| peta | P | pet´ah | 1 000 000 000 000 000 |
| tera | T | tear´ah | 1 000 000 000 000 |
| giga | G | jig´,ah | 1 000 000 000 |
| mega | M | meg´ah | 1 000 000 |
| kilo | k | kill´oh | 1 000 |
| hecto | h | heck´toh | 100 |
| deka | da | deck´ah | 10 |
| deci | d | dess´ih | 0.1 |
| centi | c | cent´ih | 0.01 |
| milli | m | mill´ih | 0.001 |
| micro | μ | mike´roh | 0.000 001 |
| nano | n | nan´oh | 0.000 000 001 |
| pico | p | pee´koh | 0.000 000 000 001 |
| femto | f | fem´toh | 0.000 000 000 000 001 |
| atto | a | att´oh | 0.000 000 000 000 000 001 |

Complete these equations if you can:

1 000 000 lomania = _____

1 000 000 000 ntic = _____

0.000 001 nesia = _____

1 000 000 000 000 tory = _____

0.000 000 000 000 000 001 rney = _____

1 000 000 000 000 000 000 rcist = _____

## LESSON 8: SI STYLE CONVENTIONS

Think of it! There is no universal language, there is no universal monetary system. But at last we stand on the threshold of having a universal measurement system, a system understood by people all over the world. To make communication easier, certain style conventions are recommended. This section cites the major conventions.

1. Use a space to separate large numbers into groups of three. Do not use a comma. In many countries a comma is recognized as a decimal point.

| Example: | Correct | Incorrect |
|---|---|---|
| | 600 300.6 | 600,300.6 |

2. Use a zero in front of the decimal point when the numerical value is a partial unit.

| Example: | Correct | Incorrect |
|---|---|---|
| | 0.6 mm | .5 mm |

3. Use a decimal to express partial units. Avoid using fractions to express partial units.

| Example: | Correct | Incorrect |
|---|---|---|
| | 0.25 kg | 1/4 kg |

4. Use uppercase or lowercase letters as they are given in the table. All abbreviations or symbols are to be used in the singular form. Do not use periods after symbols unless they conclude a sentence.

| Example: | Correct | Incorrect |
|---|---|---|
| | mm (millimeters) | mms or mm's |
| | cg | c.g. |
| | ℓ | ℓ. |

5. Prefixes must be combined with units. In common usage "kilo" means kilogram. Such usage is not preferred.

6. Avoid mixing units.

| Example: | Correct | Incorrect |
|---|---|---|
| | 12.75 m | 12 m 75 cm |

7. Avoid using multiple prefixes.

| Example: | Correct | Incorrect |
|---|---|---|
| | ps (picosecond) | μμs (micromicrosecond) |

8. Avoid capitalization of unit names (except Celsius) unless they start a sentence. Listings should be lowercase.

Example: Correct - The base unit for mass is the kilogram.

Incorrect - The base unit for mass is the Kilogram.

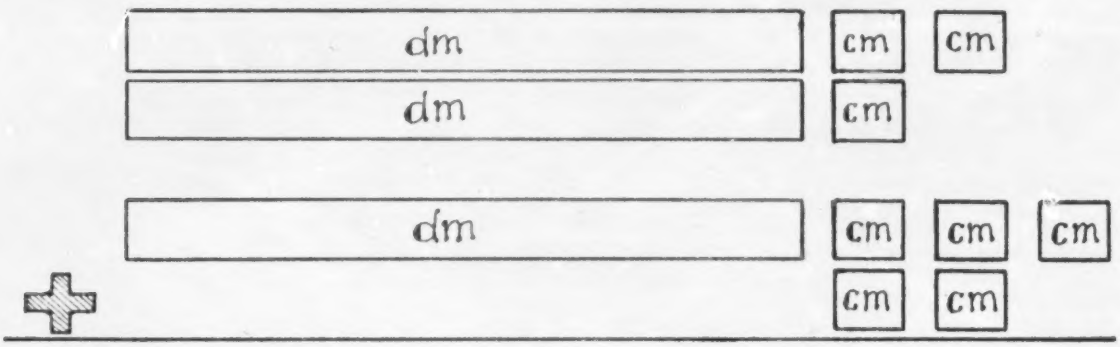
## NEXT-TO-LAST-LESSON: DECIMALS

Our number system, our monetary system, and the metric system all share a common characteristic: they are decimal in nature. Because of this, the switch to metric makes the study of decimals even more important than ever. The 4M COMPANY begins the study of decimals in the third grade. The purpose of this lesson is to illustrate how the decimal nature of the metric system is used to teach decimals.

Since a decimeter is one-tenth of a meter, decimeters are used to introduce tenths. Students make a meter strip marked in tenths of meters and use it to measure various lengths.

Similarly, since a centimeter is one-hundredth of a meter, centimeters are used to introduce hundredths. And a millimeter, being one-thousandth of a meter, is used to introduce thousandths.

Addition and subtraction of decimals are explained in terms of metric units. Thus, the problem $\begin{array}{r} 0.23\ \text{m} \\ +0.15\ \text{m} \\ \hline \end{array}$ is represented as follows:




If placed end-to-end, these units would come to the 0.38 m mark on a meter marked in hundredths. Since 10 centimeters can be exchanged for 1 decimeter, borrowing and carrying are easily explained in terms of metric units. The students soon see that adding and subtracting decimals is very similar to adding and subtracting whole numbers.

LAST LESSON: METRIC FOR EVERYDAY LIVING

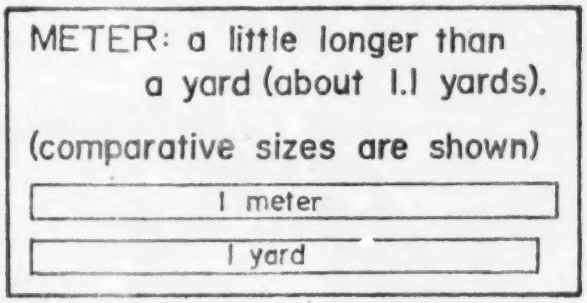
In this section we list those metric units which are most commonly used in everyday living.

Length: 1) A meter is a little longer than a yard.

2) A kilometer (1000 meters) is about 6/10th of a mile.

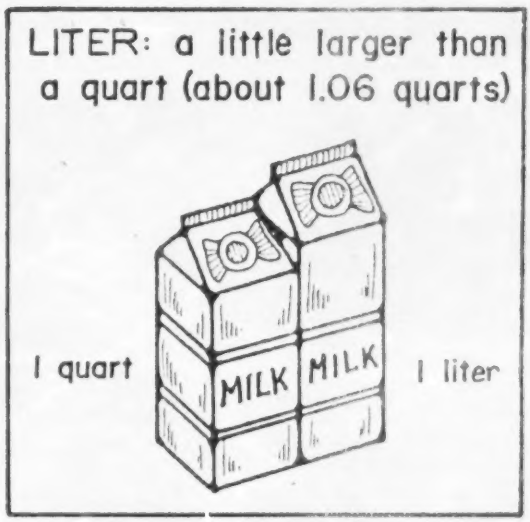
3) A centimeter (0.01 meter) is about the width of a paper clip.

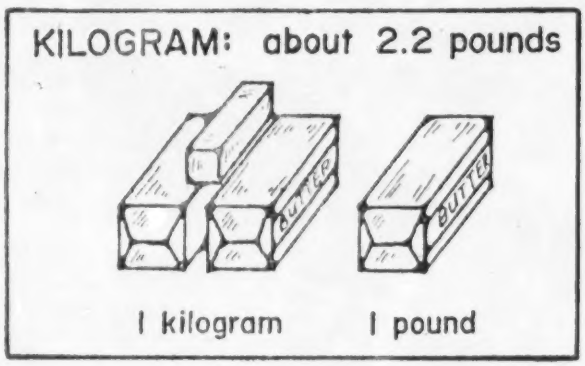
4) A millimeter (0.001 meter) is about the thickness of a dime.




Capacity: 1) A liter is a little larger than a quart (about 1.06 quarts).

2) A milliliter is 1/5th of a teaspoon.




Mass: 1) A gram is the mass of two small thumb tacks.

2) A kilogram is about 2.2 pounds.

3) A metric ton is 2200 pounds.

4) A milligram is the weight of a bee's wing.

## ANSWERS TO PROBLEMS

LESSON 3:

| | |
|---|---|
| hectogram | deciliter |
| dekaliter | centiliter |
| kilometer | decigram |
| milligram | dekagram |
| hectoliter | dekacards |
| centigram | deciArnaz |
| millimeter | centimentalist |
| centimeter | kilomanjaros |
| milliliter | millitary |
| hectoliter | decimate |
| kiloliter | kilowhats? |
| kilogram | milliscent |
| dekameter | centipede |
| decimeter | |

LESSON 7:

megalomania
jigantic
micronesia
teratory
attorney
exarcist